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Dodge Brothers Power Station

LOOP PIPING ARRANGEMENTS, AND WHITE GLASS SWITCHBOARD ARE FEATURES OF DETROIT PLANT

ALTHOUGH THE POWER STATION of Dodge Brothers at Detroit has been unable to keep step with the ever increasing demands of the huge factory, efficient operation has been developed both in the boiler and engine rooms to secure a maximum output with the available apparatus.

Of modern steel frame construction, the building is equally divided into a boiler and engine room, each 115 by 51 ft. Glazed yellow brick walls having a 10-ft. wainscoting of white tile, and a white mosaic floor are found in the engine room. The boiler room walls are also lined with glazed yellow brick, the floor being covered with red tile. Five large windows on each side of the building furnish abundant light.

STIRLING BOILERS OPERATED AT 150 PER CENT OF RATING

OPERATED as 2 batteries, are 4 Stirling water tube boilers, each rated at 750 hp., generating steam at 150 lb. pressure and operated ordinarily at 150 per cent of rating. Each boiler is provided with an 8-retort Taylor underfeed stoker, chain driven from a shaft beneath the boiler room floor. Forced draft is supplied to the stokers by 2 duplicate Sirocco fans, each driven at 1750 r. p. m. by a 102-hp. Terry turbine. These fans are located on the boiler room floor between the 2 batteries of boilers, the forced draft being controlled by varying the pressure of the steam admitted to the fan turbines by the action of Mason hydraulic damper regulators.

Placed on a platform above the forced draft fans and connected to a common shaft, is a 6 by 6-in. American Blower Co., stoker engine with chain drive and a 25-hp.

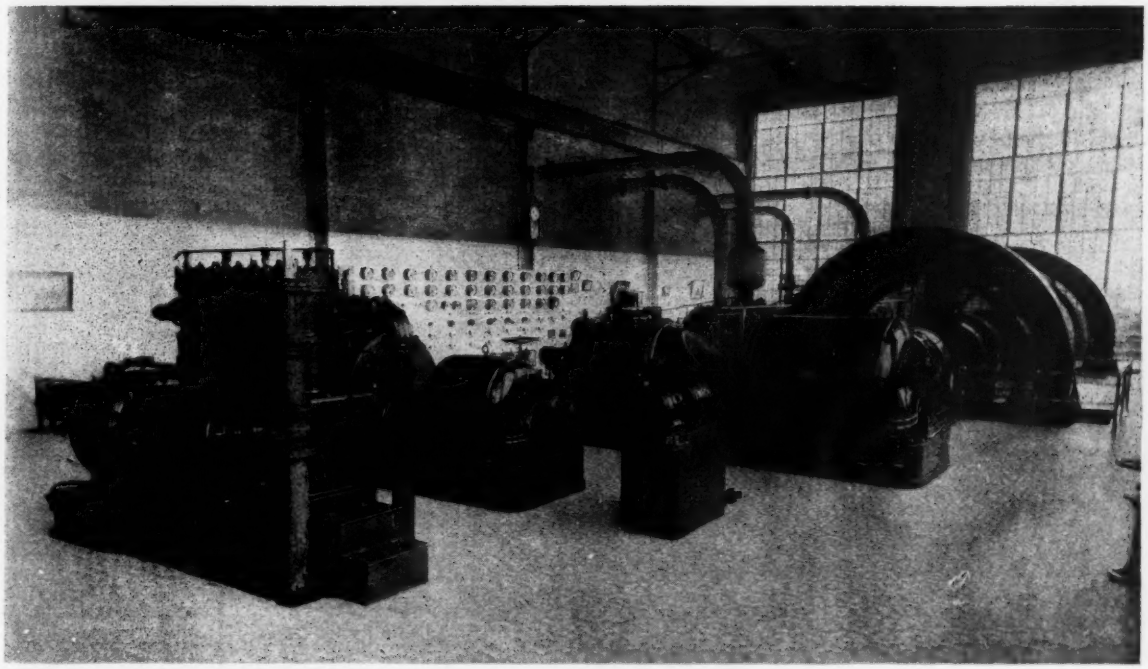


FIG. 1. DODGE BROTHERS ENGINE ROOM

belt connected motor. This common shaft is connected to the main stoker shaft beneath the floor by an enclosed double chain drive.

Draft for the boilers is provided by a 250-ft. brick stack having 12- and 18-ft. internal diameters at the top and base, and resting upon a hexagonal concrete foundation. Draft pressures over the fire and at the breeching are indicated by differential draft gages. Under standard conditions, a pressure of 0.3 in. over the fire, and 0.6 in. at the uptake is maintained. Vulcan

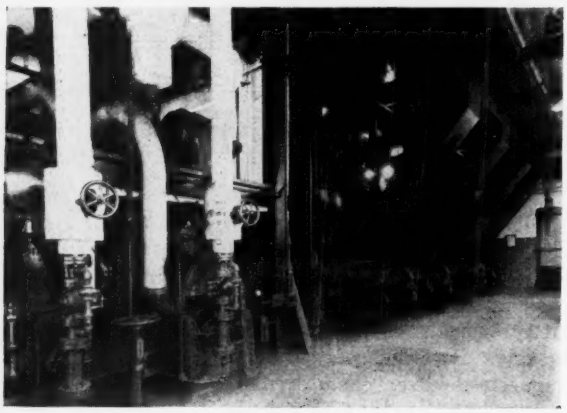


FIG. 2. FORCED DRAFT FAN TURBINES AND BATTERY OF BOILERS

soot blowers are provided on each boiler and a Bailey boiler meter connected to one boiler is indicating the rate of operation.

Lifting Conveyor in Separate Coal Tower

Coal cars run on a track alongside the boiler room and dump direct to a 25-ton receiving hopper from which the coal is then carried by an apron conveyor to a motor-driven single roll crusher having a capacity of

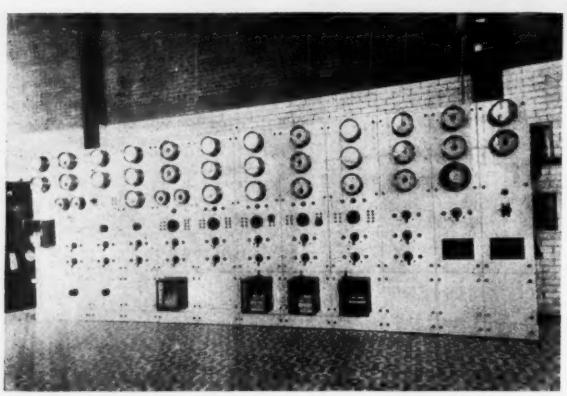


FIG. 4. WHITE GLASS SWITCHBOARD

40 tons per hour. From the crusher the coal is elevated in a coal tower to a height of 52 ft. by a Link belt bucket conveyor and then dropped upon a 20-in. belt conveyor, 145 ft. in length, passing into the boiler house. A 160-ton suspended steel hopper is provided for each battery of boilers and coal is fed to each stoker by 2 inclined spouts flaring into outlets over the hoppers. Each spout is fitted with a Richardson automatic weighing scale, mounted upon a platform, and operated by a motor-driven layshaft.

Ashes are pulled from the ash hoppers into an 8-in. suction line, installed by the American Steam Conveyor Co., and elevated to a 30-ton steel hopper outside the boiler room, from which they may be spouted either to cars or wagons.

Feed Water Piping

All condensate and returns are collected in 2 hot wells placed in the rear of the boilers and then raised

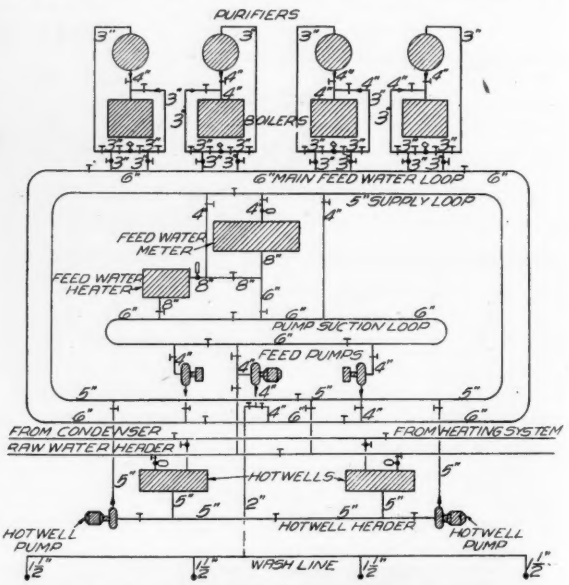


FIG. 3. DIAGRAM OF FEED WATER PIPING

to a 5-in. supply loop by 2 4-in. Roturbo centrifugal pumps, each driven at 1780 r. p. m. by a 15-hp. Allis-Chalmers motor. After being heated in a Cochrane closed heater, the feed water then passes through a V-

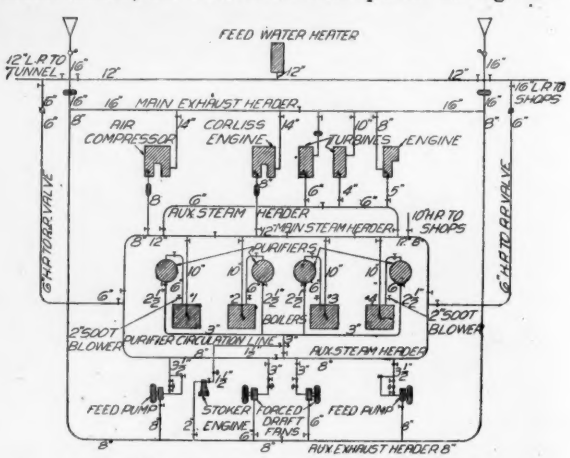


FIG. 6. STEAM PIPING ARRANGEMENT

notch recording meter as shown diagrammatically in Fig. 3. From the meter the water enters a 6-in. pump suction loop from which it is forced into the main 6-in. header by a set of 3 3-in. Roturbo centrifugal pumps. Two of these feed pumps are driven at 2200 r. p. m. by 55-hp. Curtis turbines, and the third driven by a 60-hp. Allis-Chalmers motor.

From the main feed water header the water may be passed through Hoppes live steam purifiers which are placed on top of each boiler, or pass direct to the boiler. Provision is made in the feed branch to each boiler so that the feed water may be first passed through portable weighing tanks for test operation.

Each boiler is equipped with a Copes feed water regulator and the 2 steam driven feed pumps have Copes governors. Should the demand for steam fall off to such an extent that one pump can supply all the feed water required, and at a reduced speed, the governor will throttle the steam supply to the pump turbine.

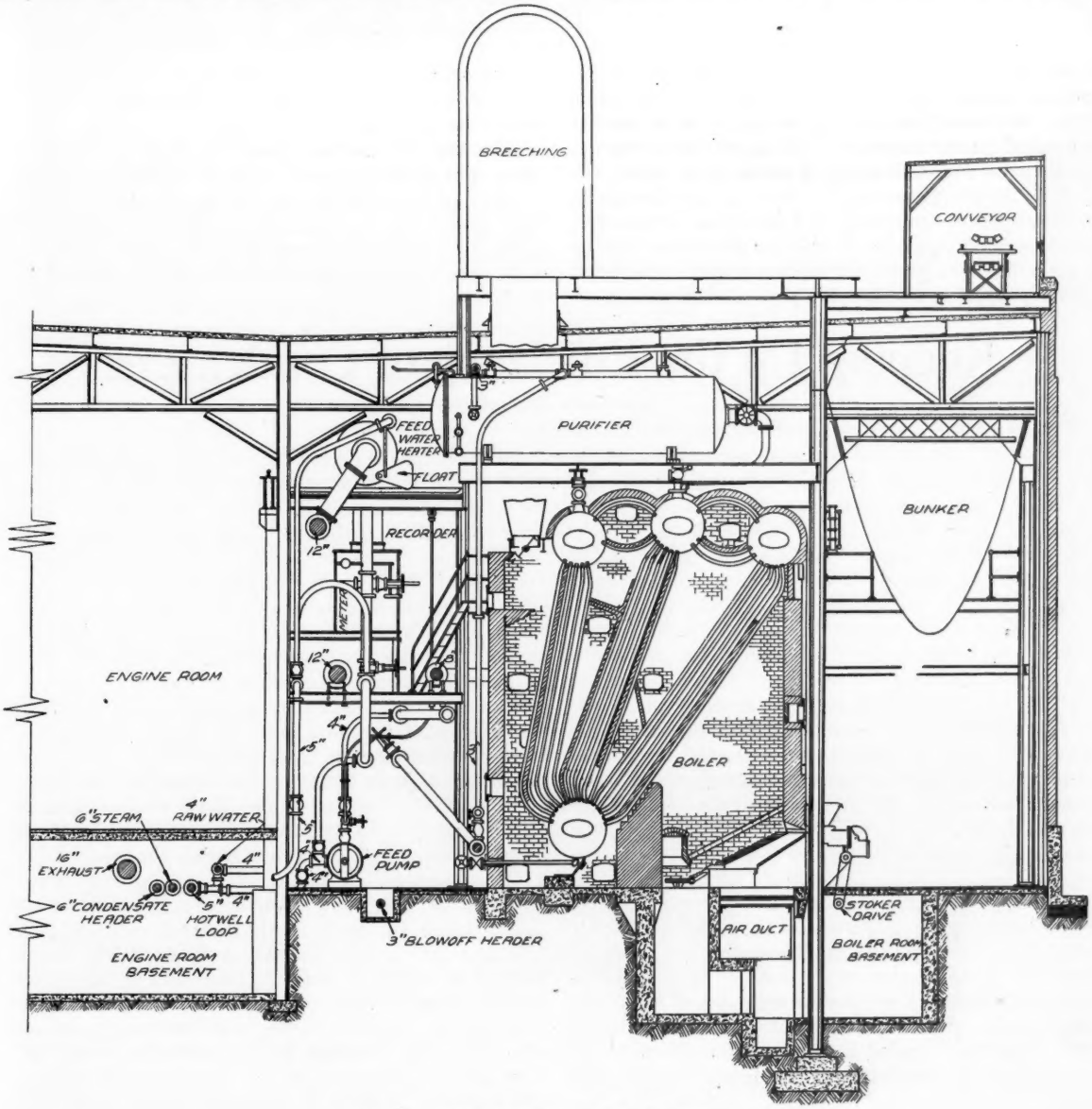


FIG. 5. CROSS SECTION OF BOILER ROOM

Service water is supplied by 2 3-in. Union Steam Pump Works centrifugal pumps, each driven at 1750 r. p. m. by a 15-hp. Allis-Chalmers motor.

Engines Exhaust to Low Pressure Turbine

In the engine room is a 22 by 34 by 36-in. cross compound Allis-Chalmers Corliss engine, driving at 120 r. p. m. a compressor having a high pressure cylinder capacity of 1800 cu. ft. of air per minute at 100 lb. pressure, while the low pressure cylinder supplies 4000 cu. ft. per minute at 40 lb. pressure. A duplicate engine operating at 125 r. p. m. drives a 500-kw. generator, supplying 440-volt, 60-cycle, 3-phase current. Similar current is also generated by a 100-kw. turbo-generator, running at 3600 r. p. m.

Exhaust steam from these units at an average pressure of 1 lb. operates a 750-kw. low pressure turbo-generator which also runs at 3600 r. p. m. and delivers 440-volt, 60-cycle, 3-phase current.

Vacuum for the low pressure turbine is supplied by a C. H. Wheeler surface condenser for which cooling water is elevated through a 12-in. line to a double fan forced draft cooling tower located on the roof. Circulation at the rate of 3500 gal. per minute is obtained from a 12-in. centrifugal pump driven at 1040 r. p. m. by a

55-brake hp. Allis-Chalmers turbine. The condenser is equipped with an 8 by 16 by 12-in. Mullen air pump.

When only a small amount of compressed air is required, a single stage triplex compressor, delivering 500 cu. ft. air per minute, at 100 lb. pressure, is operated by a 100-hp. Westinghouse induction motor.

Excitation current is supplied either by a motor driven machine rated at 50-kw. or a 100-kw. dynamo, driven at 200 r. p. m. by a Ball 4-valve engine.

White Glass Switchboard

One of the features of the engine room is the 12-panel white glass remote control switchboard shown in Fig. 4. All circuit breakers, switches and main bus bar are located in the basement. This board, which was erected by the Mutual Electric & Machine Co., of Wheeling, W. Va., is equipped with Tirrill voltage regulators, and Westinghouse indicating and recording instruments. Each generator panel has a graphic wattmeter, and on the main bus is a graphic ammeter, graphic voltmeter, graphic wattmeter, and graphic power factor meter.

High and Low Pressure Piping

From the boilers, 10-in. leads are connected to a loop header, anchored upon a gallery in the rear of the boilers as shown in Fig. 5. One side of the loop consists of 12-in. and the remainder is 8-in. pipe. Steam is supplied to the Corliss engines through 8-in. leads from the 12-in. side of the loop, and to the turbo generators and exciter engine from a 6-in. auxiliary header as shown diagrammatically in Fig. 6. Feed-pump and fan turbines draw steam from the 8-in. side of the loop, the stoker engine and purifier circulation lines being taken from a 3-in. branch. Two 6-in. branches are connected through pressure reducing valves to the low-pressure heating line which is carried through an 8 by 6 ft. tunnel to the different departments of the factory.

Exhaust steam from the engine room units enters a 16-in. line which is joined by an 8-in. auxiliary exhaust header from the boiler room units. Through 2 connections with 16-in. oil separators, the exhaust loop is joined to the distributing low-pressure main. Two 16 in. lines with back pressure valves are carried up through the roof.

Keeping Up the Efficiency of Condensers

Causes of Decreasing Efficiency; Cleaning Tubes; Air in Condenser. By M. A. Saller

THE vital part of any surface condensing outfit is the tubes, because they are the medium through which the heat transfer is made, and consequently the maintenance and care of this portion of the outfit is of extreme importance, especially since the failure of these tubes may serve to throw the entire outfit out of service, and often the generating unit which it serves. Dirty and scaled condenser tubes are also inefficient because the heat transmission is impaired, and hence a lower vacuum is secured.

Of the troubles which may be encountered in connection with condenser tubes, probably the most common is in connection with the scaling or accumulation of mud and sediment deposited by the circulating water. This accumulation of scale on the tubes naturally reduces the heat transfer in just the same manner as the accumulation of scale on boiler tubes, and the result is a noticeable cutting down in the vacuum.

Mud in the circulating water is of course the most common cause of accumulation on the tubes. This substance settles in a fine powder-like deposit on the tubes where, due to the action of the heat, it is often baked into a hard mass. A coating of scale is also sometimes brought about by the deposition out of the water of some of the impurities carried in solution, the action of the heat serving to precipitate such impurities as solid matter.

When this mud and scale collects to such an extent as to interfere seriously with the vacuum (and it must be remembered that as a general rule every inch increase of vacuum above 24 or 25 in. of mercury means that the steam consumption of the turbine is reduced from 4 to 6 per cent), the only thing to do is to take immediate steps to remove it, and in this connection it might be said that once the condenser is shut down for cleaning, the job should be done thoroughly and completely. A clean bright tube will resist the collection of mud and scale for a much longer period than an only partially cleaned tube, which offers lodgment for mud and dirt as soon as the unit is started up.

For cleaning condenser tubes, both mechanical and chemical means are employed. The mechanical method consists simply in boring or drilling out the mud and scale by means of cutters and drills similar to the devices made for cleaning boiler tubes. The driller or cutter is usually nothing more than a long rod having at its end a sharp flat scraper, curved to the shape of the tube. When the drill rotates by hand or power, the scale and dirt is cut or scraped away. In Fig. 1 are shown several efficient types of tube drills.

When the scale formation is not too hard or consists merely of a collection of fine loose mud, satisfactory cleaning action can be had by passing a good stiff wire brush at the end of a long rod through the tubes.

The chemical method of cleaning the condenser is based on the dissolving action of some chemical or compound which will loosen up the scale formation while not affecting the condenser structure. One fairly common method is to pass through the tubes on the side containing the scale formation a very weak solution of hydrochloric acid, which cuts away and dissolves the scale and sediment. The strength of the hydrochloric acid solution used will depend upon the thickness of the scale and the resistance it offers to the deteriorating action of the acid. The safest way, in order to guard against the use of too strong a liquor, is to begin with a weak solution, say 4 or 5 per cent hydrochloric acid, following which if the results are not secured the strength can be increased up to a maximum of 10 or 15 per cent. Various other special compounds are also on the market for preventing the scale formation in the tubes, but their use is comparatively limited.

Another source of trouble lies in the clogging or stoppage of the tubes because of the presence of foreign

matter, such as leaves, fish, twigs, small pieces of driftwood, and other debris in the circulating water; but where these conditions are such that this occurs frequently, it should be guarded against by the installation of a suitable strainer in the cooling water suction line.

Especially where condensers receive the exhaust from reciprocating engines, the presence of lubricating oil in the exhaust steam introduces another factor tending towards cutting down the efficiency of the tubes or cooling surface. While a great deal of the lubricating oil carried into the condenser with the exhaust steam will be washed out with the condensate to the hot well, a portion of it will cling to the tube surfaces, forming a coating in time which will have a material effect in reducing the heat transmission efficiency.

Where this coating of oil is encountered, it is usually eliminated at such times as the condenser is being cleaned or overhauled by passing through the tubes a weak hot solution of caustic soda which dissolves and carries away the oil formations. The strength of the caustic solution, made up of caustic soda dissolved in water, also depends on the thickness of the scale or oil accumulation to be removed, and therefore the safest way is to begin with a very weak solution and increase the strength as experience indicates. In cleaning out a 400-hp. tubular heater the writer has used as much as 3 or 4 lb. of caustic with excellent results.

In this as in many other things, an ounce of preventive is worth a pound of cure; hence, where oil is found in the exhaust steam going to the condenser, it should pay to install an oil separator or eliminator in the exhaust line ahead of the condenser for preventing the oil from reaching the tubes. Not only does this eliminate the cost of cleaning the oil from the condenser tubes, but it should improve the efficiency of the outfit because it does away with the oil coating which will accumulate on the tubes, and which has a decided tendency to reduce the heat transfer. The condensate is also thus made available for feeding directly to the boilers without further filtration or treatment for the removal of the oil.

While the difficulty from mud, scale and oil is probably the most common cause of trouble in connection with keeping up the efficiency of condenser tubes, perhaps the most serious class of trouble is that brought about by corrosion or pitting out of the tubes.

The corrosion of condenser tubes presents one of the mystifying phases of engineering because the source and cause of the trouble is quite difficult to identify definitely. Two condensing units may be running under almost identical operating conditions, yet one will be entirely free from trouble while the other outfit suffers considerably because of the corrosion and pitting of the tubes.

A careful study of the subject by various engineers indicates that the corrosion or pitting out of the condenser tubes is due to either, or all, or a combination of some of the following causes:

(1) Electrolytic action.
(2) Galvanic action.
(3) Chemical action.
(4) Mechanical action.

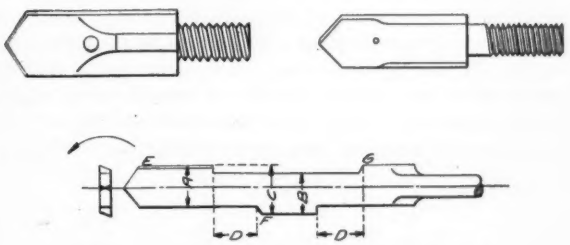


FIG. 1. EFFICIENT TYPES OF TUBE DRILLS

The electrolytic action is frequently set up in and around the condenser tubes because of the presence of stray currents grounded from the electrical system found in practically every large generating station. A very small difference in electrical potential between the various parts has been found to set up corrosion of a very serious nature. The effects of electrolytic action in the condenser tubes can be eliminated first, by coating the tubes with a nonconducting material to prevent the passage of the currents; second, isolating the condenser from contact with the electrical forces by means of nonconducting washers or fill-in pieces in all pipe lines to and from the condenser, as well as under all parts of the condenser resting on the foundations; third, by arranging to ground the electrical equipment so as to minimize stray currents.

Where trouble from corrosion is experienced it is often possible to eliminate or minimize the trouble by using tubes coated with tin or aluminum, since this substance will often resist the electrolytical action. Special paints or varnishes have also been used to coat or lacquer the tubes to help resist corrosion, but in addition to

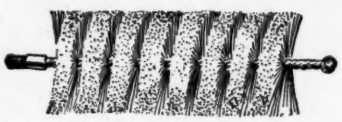


FIG. 2. WIRE BRUSH FOR REMOVING SOFT DEPOSIT

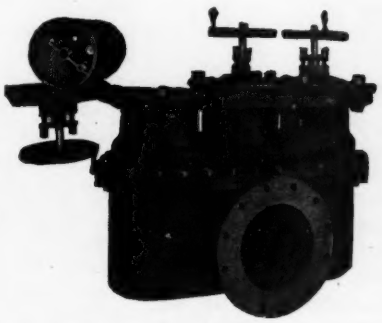


FIG. 3. MULTIPLE BASKET WATER STRAINER

FIG. 4. OIL SEPARATOR FOR EXHAUST LINES

reducing the heat transfer this method has been found to be unsatisfactory because the effect of the heat and the cold condensing water cause splitting, cracking and peeling off of the paint.

To isolate the condenser to prevent ground currents from reaching it, an insulation of hard vulcanized rubber or fibre, or heavy packing should be inserted in the pipe lines leading to and from the condenser supports, somewhat in the manner as shown on attached sketch. The detail of the flange shows how the insulation should be provided not only between the flange faces, but around the bolts and bolt heads and nuts.

A galvanic action is often set up in the tubes themselves, due to the composition or make-up of the tubes themselves. Most commonly used condenser tubes are made up of a mixture of 60 to 70 per cent copper, and from 40 to 30 per cent of zinc, with a small percentage of tin. It frequently happens that the mixture of metal from which the tubes are made is not of a thoroughly homogeneous nature, i.e., not thoroughly mixed, and the various metals do not lose their identity, the texture of

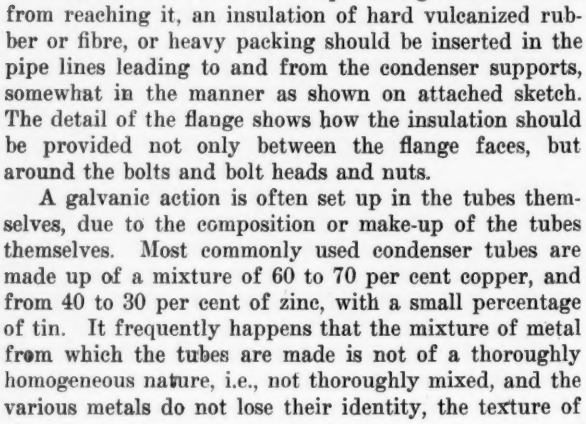


FIG. 5. LOCATIONS OF STRAINER AND SEPARATOR IN PIPE LINES TO CONDENSER

the alloy or composition being such as to expose on the surface of the tubes mechanically mixed (but not completely combined) copper and zinc. These two metals when brought into contact with the circulating water, usually containing salts of some nature, set up an electro-voltaic action, resulting in the loss or eating away of the zinc from the mixture. This galvanic action can usually be overcome, first, by inserting between the tubes in several parts of the condenser pieces of metal, such as wrought iron, which are electro-positive to the metals of the condenser tubes; second, by using special care in the manufacture of the tubes to make absolutely sure that a homogeneous mixture of the copper and zinc is secured, or by the use of special compositions, or by the use of tubes made of a single metal, such as pure copper.

Chemical action, resulting in corrosion, is usually brought about by acids contained in the circulating water. Refuse from chemical and other plants, sewage, and inorganic matter all tend to the production of metal-attacking acids, and if present in sufficient quantities will give trouble when brought in contact with the condenser tubes. A water containing inorganic matter or sewage may not be detrimental until brought in contact with the heat in the condenser when gases which have a tendency to corrode are liberated and driven off. If another source of cooling water cannot be obtained the effects of waters with corrosive tendencies can be minimized by occasionally flushing the condenser with fresh water to carry out the air and gases which collect on the tubes preliminary to their corrosive work, or by increasing the velocity of the water through the tubes.

Mechanical action is probably the least common cause of trouble, though it is mentioned so that it may be given consideration as a last resort. The presence of finely divided gritty particles in the condensing water is claimed by some to have a tendency of eroding out the tubes, their claim being based on the fact that when viewed under a powerful magnifying glass, the surface of the average condenser tube is made up of ridges which are worn deeper by what may be termed the sand-blast action of the finely divided particles of grit contained in the water.

In some stations condenser tubes will last but a year or two, while in other plants the tubes will last from 8 to 10 yr. In other cases the tubes will be corroded or eaten out in the course of a few months' operation.

Sources of Air in Surface Condensers

The presence of air and gases in a surface condenser greatly reduces the efficiency of the apparatus in that it impairs the vacuum and imposes extra and unnecessary work on the air pump, and therefore its prevention and elimination should call for very careful attention on the part of the plant operator.

When the exhaust steam is brought into contact with the tubes of the condenser, it immediately cools, is condensed, and flows away as water. But the air and gases entrained and carried in the steam act differently. They do not condense, but accumulate in pockets and form a non-conductive layer about the condenser tubes, naturally cutting down the heat transmission efficiency. One authority, for instance, has found that with a condenser temperature of 120 deg. the amount of heat transmitted from the vapor through the condenser tubes to the cooling water was reduced at least 50 per cent when a quantity of air was introduced into the condenser with the steam. Stating it another way, to obtain the same amount of effective condensation with air present it would require a condenser twice as large as would be required in case the air was entirely eliminated.

The importance of the matter of air in condensers is further demonstrated by the fact that in order to increase the vacuum from 28 to 29 in., it is necessary to double the capacity of the air pump in order to remove satisfactorily the air and gases.

In ordinary service the principal sources of air in the exhaust to the condensers are

(1) Air dissolved in the feed water and carried along with the steam.

(2) Air leakage or infiltration of air through joints or spongy spots in the exhaust piping, condenser shell, turbine casing, or through the piston rod packing and valve stem glands of the engine cylinder.

(3) Air liberated by the decomposition, under the heat of the steam, of lubricating oils, boiler compounds, etc.

Taking up the first cause, it should be borne in mind that water will absorb one-twentieth of its volume of air, and will also take into solution at ordinary temperatures carbonic acid gas usually present in the air in large quantities, up to its entire volume.

When the feed water is fed directly into the boiler through a closed system, such as a tubular heater or economizer, the air and gases contained in the feed water are naturally imprisoned and carried along with it, and when subjected to the heating action in the boiler are again liberated and carried off with the steam, finding their way through the engine or turbine into the condenser.

The most effective method for eliminating, or at least minimizing to the greatest extent, the quantities of air and gas present in the steam, is to drive off these air and gases before they enter the steam system, i. e., before they are fed to the boiler. The simplest method for accomplishing this is by spraying the feed water through an open steam bath, as provided for in the case of the open type feed heater. While practically all the air and gases are driven off from water by heating and boiling, the action is facilitated if the water is agitated and broken up into a spray so that the air can liberate itself freely. Provision should also be made for carrying away air that has been driven off by venting the heater freely to atmosphere. The proof that air and gases are driven off in the open heater, and to a very appreciable quantity, is found in the fact that if the air vent pipe is closed the air will soon accumulate in the heater, air-log it, and cause a falling off in the temperature obtained.

It has been found in a number of cases that the action of driving off the air and gases from the feed water in an open heater has enabled the vacuum in the condenser to be raised from one to one and a half inches under the same condition as previously, and when it is considered that every inch increase in vacuum over 24 or 25 in. of mercury means a reduction in steam consumption of from 4 to 6 per cent, the process of thus openly pre-heating the water is quite worth while.

Where the feed water is heated and passed through a closed tubular heater the air while liberated to an extent is not released because the circuit is a closed one, and hence the air must be carried on to the boiler. For such installations various schemes are employed for getting rid of the air, such as placing air chambers or air extractors in the feed lines just ahead of the boiler, but these give only incomplete results because of the speed at which the water is traveling through the small feed pipes, and because the eliminating apparatus is usually not large enough to handle the great quantity of air to be taken care of.

The matter of air leakage through the exhaust piping, stuffing boxes, etc., is one that cannot be taken care of so conveniently as the air entrained in the water because the sources of air infiltration are usually small, though great in number and scattered in location.

The best test to determine the extent of air leakage in the condensing system is to pull a vacuum of 25 or 26 in. on the condenser, and then close up the entire outfit, allowing it to stand for an hour or two, at the end of which time the drop in vacuum is noted. It is usually regarded as a satisfactory installation for all practical purposes if the drop in vacuum does not exceed 3 in. of mercury per hour. If the drop is greater than this, all the exhaust connections should be gone over carefully to see that all the joints are pulled up tightly, and that the packing is in good condition. Considerable air is often drawn in through porous spots in the castings comprising the condenser shell, turbine casing, pipe fittings, etc., and it is usually desirable to have all these surfaces coated with a good heavy non-porous paint.

As showing the enormous rate at which air can enter into the condensing system through a small leak or opening, it is estimated that the rate of flow of air at 60 deg. at atmospheric pressure, into a vacuum of about 14 or 15 in. is about 4½ cu. ft. per sec., or some 16,000 cu. ft. per hr. for each square inch of opening, depending, of course, on the shape and size of the opening.

Another source of air leakage is in connection with the valve stem and piston rod packings. It is almost impossible absolutely to prevent leakage of air through these points for any length of time, but the leakage should be kept at the minimum point by making frequent inspections and using the best of packing in the stuffing boxes.

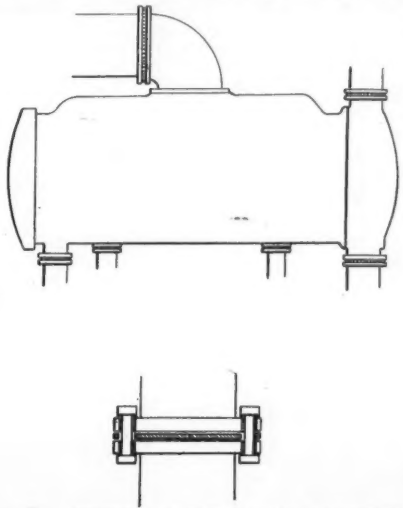


FIG. 6. METHOD OF INSULATING CONDENSER

Every condenser outfit should also be protected with an atmospheric relief safety valve to prevent accumulation of pressure in case of the failure of the condensing water, etc., and since these valves are usually of large diameters, because of the great bulk of steam to be handled, it is not uncommon to find that air is drawn in around the seats of the valve disc. This can be remedied by keeping the valve disc ground tightly to its seat, and then flooding the top of the valve disc and seat with a layer of water, thus providing a water seal to prevent the passage of air.

The introduction of air into the system due to the decomposition of lubricating oil or boiler compounds is not as frequent an occurrence as the two other main sources mentioned, but it is stated so that the possibility will not be overlooked. The use of an oil which will not decompose, or the elimination of the use of a compound which creates the undesirable air and gases are, of course, the obvious steps to take where trouble from this source is encountered.

Belting*

METHODS OF LACING AND FASTENING BELTS; TREATMENT TO LENGTHEN LIFE AND DECREASE SLIP

WHERE it is impossible to employ a cement splice, lacing or metal fastenings must be used. A hinge lacing of some form is usually the most satisfactory, particularly where the belt runs over a small pulley. This may be made either by the use of leather lacing, passing lacing from one side of the joint to the other, between the ends of the belt, or it may be made with a wire lacing having a separate wire laced into each end of the belt, forming on side of a hinge and the 2 parts of the hinge joined by a rawhide pin. This form is best done on a belt-lacing machine, and when it is used the belt should be cut short enough to take care of the stretch and a distance piece 6 in. long put in when the belt is new. This distance piece can be changed for others 5, 4, 3, 2 and 1 in. in length, as the belt stretches.

Various methods of lacing have been devised, a number of which are shown herewith. In arranging the holes for lacing, it should always be remembered that be no tendency of the joint to throw the belt to one side or other of the pulley.

When lacing leather belts, the size thong to be used is as follows: For small belts, ¼-in.; for 4 in. to 8 in., ⅜-in.; for 8 in. to 15 in., ½-in.; and over 15 in., a ¾-in. thong. Usually the holes are made oval in shape, with the long axis lengthwise of the belt. This is particularly necessary where a belt is to be double laced.

When using metal fasteners, care should be taken that the points project well through the leather and are turned over and sunk into the belt so that they will not strike on the pulley, as otherwise there will be a slip on the pulley when the joint passes it, producing irregularity in the speed.

TREATMENT

BELTS forming an expensive part of the equipment of the plant employing such form of drive, it is imperative that they receive proper attention and treatment.

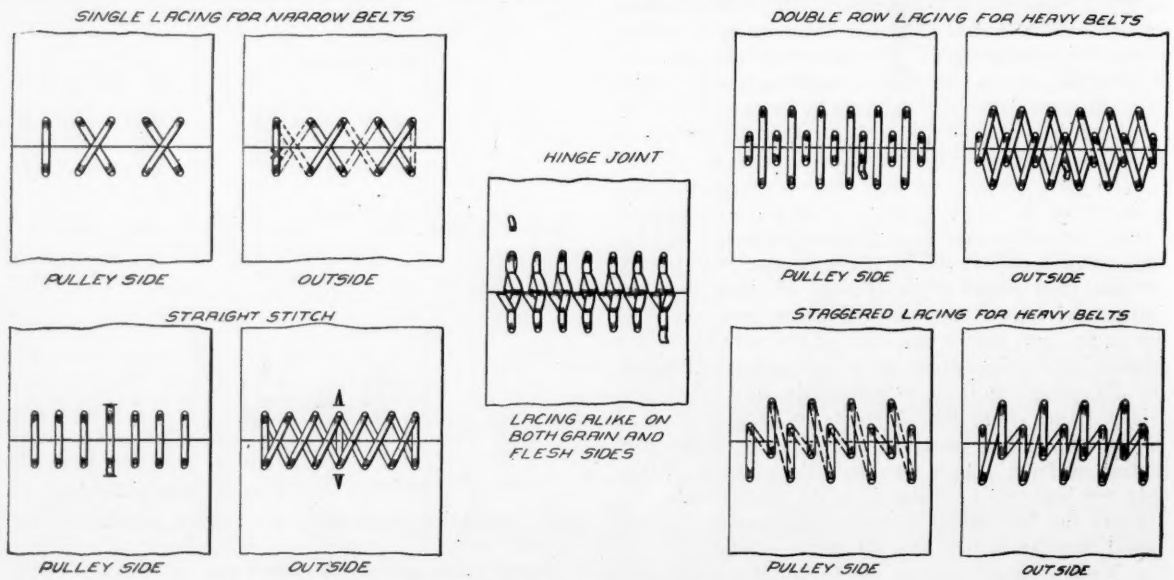


FIG. 8. FORMS OF BELT LACING COMMONLY EMPLOYED

several small holes will hold better than a few large ones, since the load which each hole will carry is limited to about 500 lb.

For a 3-in. belt use 4 holes in each end, 2 in each row staggered. For a 6-in. belt use 7 holes in each end, 4 in the end row and 3 in the second row. For a 10-in. belt use 9 holes in each end, 5 in one row and 4 in the other. The holes should be ¾ in. from the sides of the belt and the first row ⅞ in. from the end; the second row should be 1¼ in. from the end. When small single belts carry but a light load, 1 row of holes is frequently sufficient.

In lacing, care should be taken either that the lacing runs straight on the pulley side or else that it is symmetrical with respect to the center, so that there will

Systematic care will result in a considerable decrease in the belt expense and where there are many belts, a regular belt room with outfit is well worth maintaining.

Rosin, mineral oils and water should never be allowed to get into belts, although there are a number of waterproof belts on the market today capable of withstanding continuous service in moist and wet places. The fact that a belt is waterproof does, however, not justify its being needlessly wet. In case oil or grease get onto the belt, it should be cleaned with gasoline, and after that belt dressing or neats-foot oil applied to give the required elasticity. Treating new belts with a dressing consisting of equal parts fish oil and tallow before using will give them longer life and better pulling power. Too frequent application of such as the above-mentioned oils to a new belt has a tendency to render the leather soft and flabby, thus causing it to stretch and

*Continued from page 307, April 1 issue.

making it liable to run out of line. It is, therefore, advisable that after the first application no dressing be applied unless the belt shows signs of dryness.

Never use animal oil or grease on rubber belts, as it will greatly injure and soon destroy them. According to Kent, rubber belts will be improved, and their durability increased by applying with a painter's brush and allowing it to dry, a composition made of equal parts of red lead, black lead, French yellow litharge, mixed with boiled linseed oil and japan enough to make it dry quickly. The effect of this will be to produce a finely polished surface. If from dust or other cause, the belt should slip, it should be lightly moistened on the side next the pulley with boiled linseed oil.

Some forms of belt dressings, the compositions of

FIG. 9. BRISTOL'S PATENT STEEL BELT LACING

which are trade secrets, appear to possess the property of increasing the coefficient of friction between the belt and the pulley, and thereby enable a given power to be transmitted with a lower belt tension than with undressed belts. A dressing of this kind is Cling-Surface, a neutral preservative, stated to keep the belt in vigorous health, pliable and waterproof and prevent drying or cracking. Cling-Surface may be used for leather, cotton or camel-hair belts or manila rope into all of which it penetrates, while for good rubber or balata belts in light application, it refreshes the surface rubber and in old belts waterproofs any canvas exposed due to the absence of the rubber.

Royal Worcester Belt Preservative, a semi-liquid compound, penetrates and preserves the fibre of the

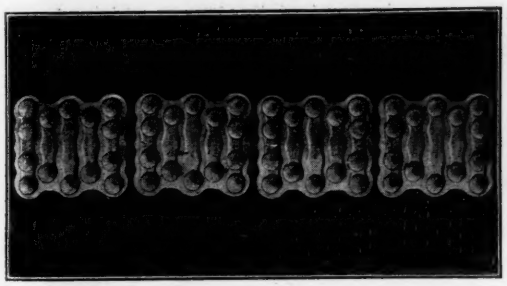


FIG. 10. JOINT WITH CRESCENT BELT FASTENER

leather and keeps the belt in a pliable condition, prolongs its life and prevents slippage. This preservative may be applied either hot or cold; but if warmed gently until liquid and then applied, it penetrates somewhat more quickly. In order to treat a belt, wipe it clean, put a little of the preservative on a piece of cotton waste and apply to the moving belt. When belting appears dry or harsh, it should receive a light coat of the preservative on both sides.

Dixon's belt dressings are made in both liquid and solid form, the former being known as Dixon's Traction Belt Dressing and the latter as Dixon's Solid Belt Dressing. Both preparations are said to penetrate the fiber of the leather, strengthening it and bringing back lost vitality. The liquid will also waterproof belting, preserving it against the spatter of water, wet steam and destructive chemicals. Manila transmission ropes may also be improved by an occasional application of Traction Belt Dressing, penetrating into the core of the rope, waterproofing the fibers, keeping them flexible and preventing decay.

To treat the belt with the liquid dressing, warm it until it is thin and apply evenly with a brush or swab, making sure that all accumulations of dirt and grease have been removed from the belt.

A dressing obtainable in the solid only is Stephenson's Bar Belt Dressing. This not only prevents slipping, but also preserves the belts to which applied,

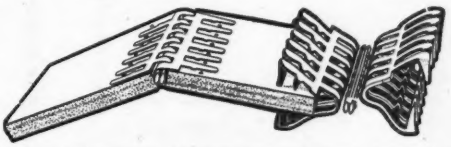


FIG. 11. ALLIGATOR HINGE-JOINT STEEL BELT LACING

accomplished by pressing the stock against the running belt.

Quaker City Belt Dressing is another of the liquid dressings and is applicable to both leather and rubber belting. It should be kept in a warm place and applied to pulley side of belt with a brush or woolen cloth.

In order to clean and restore dirty belting, coil the belt loosely and place it on edge in a tank containing a sufficient quantity of naphtha to cover it. Allow it to remain in this bath for 12 hr.; then turn the belt over, standing it on the other edge. After the belt has remained in the naphtha another 10 or 12 hr. or until it is sufficiently clean, raise it and allow the naphtha to drip back into the tank. Lay the belt flat and stretch and shake it until dry. While this naphtha bath will

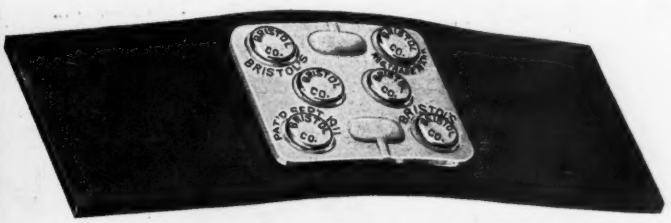


FIG. 12. JOINT WITH BRISTOL'S PATENT STEEL BELT PLATES

not affect the leather or the glue in the center of the belt, it may tend to open the joints at the edges. In case this happens, the glue may be scraped off and the edges re-cemented. The belt will now, due to this treatment, be a trifle hard and should be treated with a reliable belt dressing before being replaced on the pulleys.

(To be continued.)

GLASER'S ANNALEN gives the following as a substitute for babbit metal, the alloy having been devised by German metallurgists because of the scarcity of copper: 63.4 per cent zinc, 21.3 per cent tin, 12 per cent lead, 3.3 per cent copper. Melt red brass and the tin and lead in that order; preheat the zinc to 400 deg. F. and add to the molten alloy.

Coal and Ashes Handling and Storage--V

For Small Plants, Simpler Apparatus Is Suitable for Saving Time and Expense. By Henry J. Edsall

SMALL RESERVE STORAGE of about 600 tons, or 30 days' supply, for a boiler house using about 20 tons of coal per day, is shown in Fig. 14. It is served by a gravity discharge elevator-conveyor encircling the pile, with the lower run in a tunnel underneath, so that the coal can be either delivered to storage from the upper run, or taken from storage by means of gates and chutes

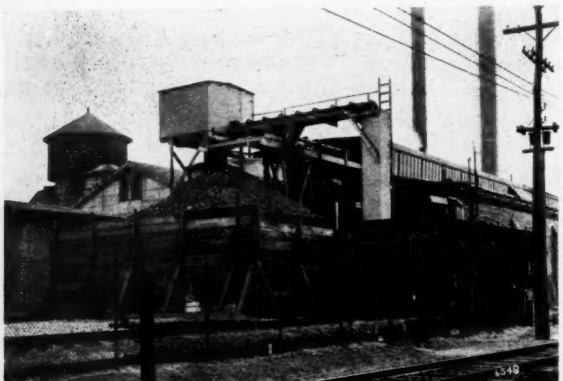


FIG. 14. BUCKET CONVEYOR SYSTEM FOR STORING AND RECLAIMING IN A SMALL PLANT

to the lower run of the conveyor. There is also a flight conveyor running into the boiler room and delivering the coal on the floor in front of the boilers. This conveyor receives its coal from the upper run of the gravity discharge machine.

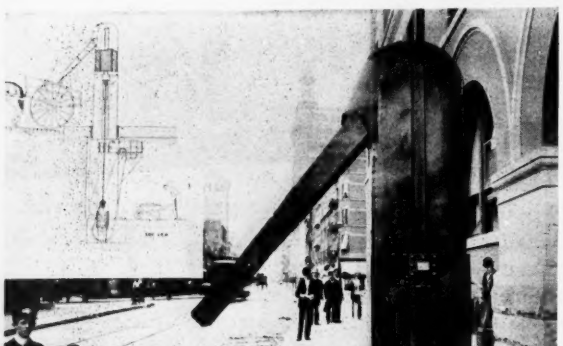


FIG. 17. TELESCOPE ASHES ELEVATOR FOR DELIVERING FROM BASEMENT TO CARTS

Outside storage served by an electric mono-rail machine traveling on a single rail track over the storage pile and running into the boiler room and delivering the coal direct to the stoker magazines, is shown in Fig. 15. This type of equipment does away with the overhead storage in the boiler room, but the supply is entirely dependent on the continuous operation of the mono-rail machine and necessitates keeping an operator on duty practically all the time.

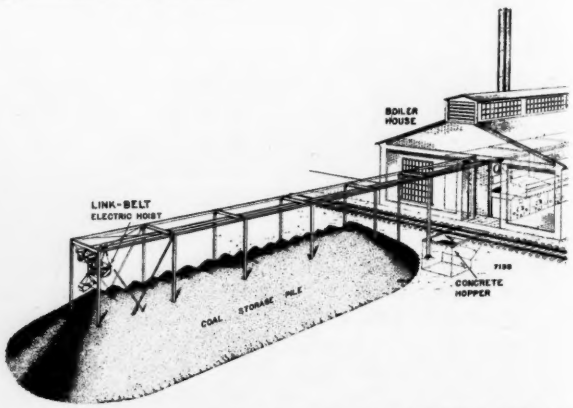


FIG. 15. MONO-RAIL EQUIPMENT WITH NO INSIDE STORAGE DELIVERING FROM PIT TO STOKERS OR STORAGE, OR FROM STORAGE TO STOKERS

Figure 16 shows a simple equipment for a small boiler room, consisting of an inclined flight conveyor receiving coal from a track hopper and depositing it in a pile against the boiler room wall. Openings in the boiler room wall allow the coal to flow through onto the boiler room floor in front of the boilers as long as the pile is full or nearly full, and when it gets low the firemen wheel it into the boiler room from the pile.

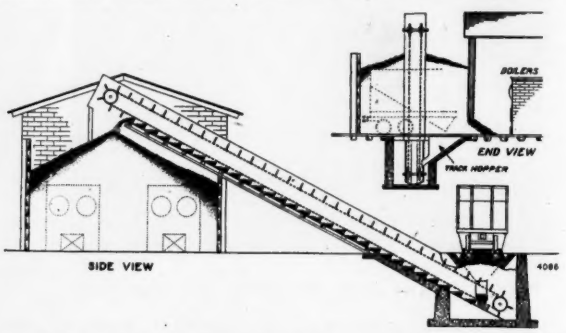


FIG. 16. SIMPLE FLIGHT CONVEYOR FOR HANDLING FROM CARS TO SMALL STORAGE

Ashes Elevators

Some ashes handling equipments have already been described in connection with the coal handling equipments, the best of these being the ones where both coal and ashes are handled in pivoted bucket carriers. In small plants the ashes are usually raked out onto the floor and shoveled into wheelbarrows, and then either dumped outside in a pile or delivered to an ashes eleva-

tor or a skip hoist which takes them up and delivers them to an overhead bin for disposal to wagons or railroad cars.

Figure 17 shows a standard ashes elevator elevating the ashes and delivering direct to a cart, the casing being made telescopic so that the upper part of the machine can be lowered into a vault underneath the sidewalk. If properly constructed, these machines give good service, but special steel bushed chains and chilled wheels have to be used to stand the severe service in handling ashes, and everything has to be designed with a view to durability. Where storage is desired, the ashes may be delivered to a 5-ton overhead steel tank, arranged so that wagons can back under it and draw out the ashes. While larger ashes bins are usually built of concrete or concrete and brick, the small tanks can be built much more cheaply of steel, and with the amount of ashes handled in small boiler rooms the additional expense for concrete and brick is not justified.

Combustion of Bituminous Coals*

DESCRIPTION OF COMBUSTION PROCESS AS IT OCCURS IN HAND-FIRED AND STOKER-EQUIPPED FURNACES. BY HENRY KREISINGER

COMBUSTION of coal is a chemical combination of its combustible ingredients with the oxygen of the air. The chief of these ingredients are carbon and hydrogen, designated by the chemical symbols C and H, respectively, and are present in the coal in various chemical combinations.

When carbon burns completely, the product of combustion is carbon dioxide, usually designated by the symbol CO_2; when only partially burned, the product is carbon monoxide, designated by CO. By supplying more oxygen, CO can be burned to CO_2. The hydrogen of the coal burns to water vapor (H_2O), which condenses to water when cooled to atmospheric temperature. The furnace gases consist mainly of nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), and sometimes a small amount of carbon monoxide (CO).

AIR AND COAL SUPPLY

SUPPLYING the right amount of air is very important for efficient burning of coal under steam boilers. When the air supply is too small the coal does not burn completely and all the heat in the coal is not developed, while when the supply is too large, heat is wasted by the excess air being heated while passing through the furnace and carrying the heat out through the stack.

The method of feeding the air and the coal into the furnace is also very important, because of its effect upon the rate and the completeness of combustion of the coal. The most commonly used methods are shown in Fig. 1.

In the hand-fired furnace shown at A, the coal is fed intermittently from the top and the air in continuous stream through the grate from the bottom. Some air is, or should be, also supplied over the fuel bed.

In the side-feed type of stoker shown at B, the coal is fed continuously from the side and the air from the bottom at right angles to the feed of coal. The coal comes down the grate by gravity and the agitation of the grate bars.

The chain grate is another common type that can be classed as side-feed stoker. With it the feeding of coal is not dependent on gravity, but is accomplished by the motion of the entire grate surface. Both the air and coal are fed in continuous stream.

In the underfeed type of stoker both the coal and air are fed in the same direction and with uniform flow.

In most mechanical stokers air is also introduced in various ways over the fuel bed. In the side-feed type the air is usually supplied through special tuyeres placed immediately above the fuel bed, at the entrance of the coal into the furnace. Some air also enters through the coal in the magazine.

In the chain-grate stoker the additional air is introduced over the fuel bed through the coal in the magazine, through the thin fuel bed near the bridge wall, and through leaks along the side walls.

In the underfeed stoker, the concentrated air blast frequently passes through channels in the fuel bed. Air is also allowed to pass into the furnace through the damper in the front door of the furnace.

The rate of heating of the freshly-fired coal is another very important factor in the combustion of coal and the furnace design. This process should be slow and uniform so as to obtain a like rate of distillation of the volatile matter of the coal and a spreading of the

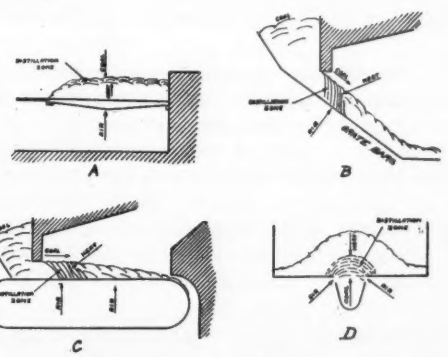


FIG. 1. TYPICAL COMMERCIAL FURNACES CLASSIFIED ACCORDING TO METHOD OF FEEDING AIR AND COAL

process of distillation over longer periods, so that the uniform air supply introduced over the fuel bed may be always sufficient to burn completely the products of distillation.

Figure 1 shows the way the freshly fired coal is heated in the four types of furnaces, the arrow marked "heat" indicating the direction in which the heat travels.

In the hand-fired furnace the freshly fired coal is heated by convection by the hot gases passing through it, by conduction by coming in contact with the hot coal

*From a paper read before the N. A. S. E., Washington, D. C.; published by permission of the Director of the Bureau of Mines.

beneath it, and also by radiation from the hot parts of the furnace. The heating is rapid and the volatile matter is distilled in a short time. In the side-feed type of furnace the coal is heated by conduction from the hot coal and by radiation from the arch and other hot parts of the furnace. This is also true of the chain grate furnace. In the underfeed stoker the coal is heated by conduction and radiation from the hot coal above it. Owing to the fact that the heat travels in the opposite direction to the feed of air, the convection factor is negative and reduces the rate of heating. In most mechanical stokers it may take 5 or 10 min. to heat the coal through a temperature range of 2000 deg. F., whereas, in the hand-fired furnace, some of the coal is heated through the same range in less than a minute. This is particularly true when the coal is slacky and is spread thinly over the hot fuel bed.

Combustion in Fuel Bed

In any coal-burning furnace the combustion process takes place partly in the fuel bed and partly in the combustion space. The products of gasification rising from the fuel bed are burned in the combustion space after sufficient air has been added and mixed with them. The

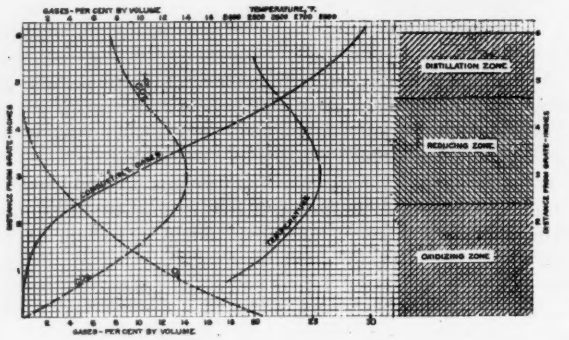


FIG. 2. COMPOSITION OF GASES AND TEMPERATURE IN THE FUEL BED AT DIFFERENT HEIGHTS FROM THE GRATE IN A HAND-FIRED FURNACE

fuel bed then acts principally as a gas producer and gas retort.

The process of combustion in a fuel bed of a hand-fired furnace is illustrated in Fig. 2, which shows the composition of the gases in a 6-in. fuel bed at different heights from the grate.

The scale at the side gives the distance from the grate and the scale at the bottom and top the percentages of various gas constituents and also the temperature. The gases, oxygen (O_2), and carbon dioxide (CO_2), are represented by the two curves designated by their chemical symbols. The percentages of combustible gases CO, CH_4, H_2 and unsaturated hydrocarbons present are added and represented by the heavy solid curve labeled "combustible gases." The temperature is shown by the light solid curve. The air containing about 21 per cent of O_2 enters through the grate and as it passes through the fuel bed burns the carbon to CO_2, the percentage of free oxygen quickly decreasing. At a distance of 3 to 4 in. from the grate the free oxygen practically disappears. The CO_2 that has been formed passes through the upper layers of the fuel bed and is reduced by contact with the hot coal to CO. This reduction process continues to the top of the fuel bed. At the point where the reduction of CO_2 to CO becomes prominent, the CO_2 is at its maximum of about 14 per cent, the oxygen is nearly all used and there is a small percentage of CO. When the gases reach the top of the fuel bed the CO_2 is reduced to about 8 per cent, and the CO is increased to about 20 per cent. This CO, together with the gases distilled from the freshly fired coal at the top of the fuel bed, forms about 32 per cent of combustible gases which rise from the fuel bed, and must be burned in the combustion space. Thus the fuel bed consists of 3 zones, which are indicated at the left of Fig. 2. The lowest 3 in. of fuel bed is an oxidizing zone. In it the coal is oxidized to CO_2; only a small amount of CO is found in this zone. The next 2 or 3 in. is a reducing zone; in it the CO_2 is reduced to CO. The top 1 or 1½ in. of the fuel bed is the distillation zone; in it the volatile matter is distilled from the freshly fired coal. The zones are not sharply separated from each other, but gradually merge into one another.

In Fig. 2 the light solid line shows the temperature in the fuel bed; this curve indicates that the temperature

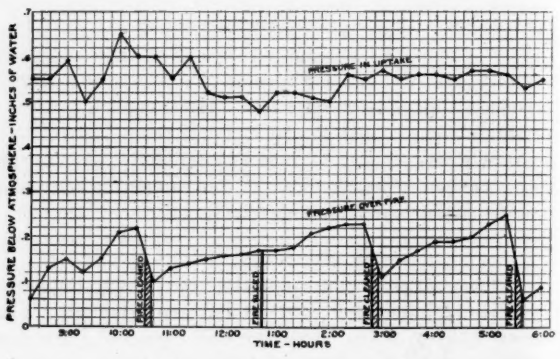


FIG. 3. EFFECT OF CLEANING FIRES ON DRAFT IN THE FURNACE

is the highest at the point where oxygen disappears; it gradually drops towards the top of the fuel bed, showing the effect of the reduction process.

With a level fuel bed 5 in. or more thick, only ½ of the 14 lb. of air necessary for the complete combustion of the coal can be supplied through the fuel bed; that is, no matter how much air is supplied through the fuel bed, each 7 lb. of air gasifies 1 lb. of coal. The more air supplied, the faster is the coal gasified, the degree of completeness of combustion remaining the same. It is, therefore, impossible to control completeness of combustion by regulating the supply of air through the grate. Only the rate of combustion can be controlled thereby. The completeness of combustion can be controlled only by the quantity of air added over the fuel bed and by burning the gases rising from the fuel bed in the combustion space. On the average about 7 lb. of air must be supplied over the fuel bed to make complete combustion possible.

How Air Should Be Added Over Fuel Bed

The air supplied over the fuel bed should be introduced as near the surface as possible. It should be introduced in a large number of small streams and should enter at a high velocity. Admitting the air close to

the surface of the fuel bed causes the volatile matter that is being distilled from the coal to burn directly to products of complete combustion before it is decomposed by the heat into light gases and soot. Large number of small streams coming in at high velocity facilitates the mixing of the combustible gases rising from the fuel bed with the air, thus making rapid combustion possible.

In commercial hand-fired furnaces the additional air over the fuel bed is introduced through small holes in the firing doors, or special openings either above the door or in the dead plate. In a few cases the air is also introduced through the bridge wall. In order to make the air flow into the furnace there must be either sufficient draft over the fire, or, the air must be supplied under pressure with a blower. With natural draft installations the draft over the fuel bed determines the amount of air that can be supplied over the fires, because the openings through which the air flows into the furnace remain usually constant. The draft over the fuel bed is not, however, always proportional to the demand for the additional air. Thus, after cleaning a fire, the air flows freely through the grate and rapidly gasifies the coal, producing a large volume of combustible

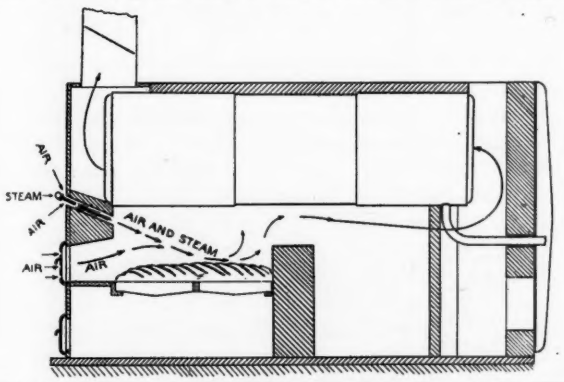


FIG. 4. ACTION OF STEAM JETS IN BRINGING AIR TO THE SURFACE OF FUEL BED

gases. Because of this free flow of air through the fuel bed, the draft over the fire is low. On account of this low draft, insufficient quantity of air is drawn into the furnace over the fuel bed, and incomplete combustion and smoke result. The low draft after cleaning is illustrated in Fig. 3, which gives the variation of draft over the fuel bed on a boiler test made at the Government Fuel Testing Plant. Immediately after cleaning, the draft over the fuel bed is very low and gradually increases as the clinker and ash accumulate on the grate and increase the resistance to the passage of air through the fuel bed.

Use of Steam Jets

In ordinary hand-fired installations it is difficult to introduce the air close to the surface of the fuel bed. The air which flows into the furnace through the various openings enters at low velocity and can not penetrate to the surface. It tends to flow in a separate large stream over the stream of combustible gases rising from the fuel bed. To improve this condition, steam jets are frequently used to introduce air into the furnace at high velocity and to mix the air coming in through other openings with the stream of combustible gas. The action of steam jet is shown in Fig. 4. Air coming in through the openings in the firing door is blown by the steam jet against the surface of the fuel bed, causing the volatile matter which is being distilled from the freshly fired coal to burn to products of complete combustion instead of being first decomposed into soot and gases. The soot when once formed is hard to burn in the rarefied oxygen of the furnace gases.

Balanced Draft

With balanced draft a sufficient quantity of air cannot be supplied over the fuel bed to insure complete combustion, and special provision must be made to supply this air under pressure by means of blowers or steam jets.

(To be continued.)

Uses for Soap as a Lubricant by the Electrician

By Harry B. Stillman

ONE OF of the most useful all-around articles in switchboard or panelboard construction is a bar of the ordinary yellow laundry soap. This makes an excellent lubricant when drilling copper, brass, asbestos, hard rubber or fiber. Touching the drill occasionally with a little soap will help the drill to cut quicker and cleaner, and will usually prevent the drill from sticking or binding, which often happens when drilling copper or brass. There is also less danger of the drill overheating when a little soap is used.

In tapping or threading copper and brass, soap should be used freely. This aids the tap in cutting a full thread, with less possibility of breaking the tap or stripping the thread. In the experience of many, soap has been found to be a far better lubricant than oil in tapping, as oil has a tendency to clog up the channels of the tap with chips. This clogging is apt to tear or strip the thread.

Wood screws for cabinet work, or for panel trims or mats can be screwed in much easier if the screw is first touched to a little soap before starting in the wood.

For particular soldering jobs a little soap rubbed around the spots where a soldered joint is to be made will prevent the solder from spreading around to parts where it is not wanted.—Electrical Review.

Trade opportunities are open, as given in the Commerce Reports of the Bureau of Foreign and Domestic Commerce, as follows:

In Spain, a company is in the market for all kinds of hand or steam power pumps, electrical goods, wire and wire cables for mining purposes. Quotations are to be c.i.f. destination, or f.o.b. New York, and payment will be made by cash against documents. Correspondence should be in Spanish, the number of this item being 23,921.

In New Zealand, an engineer is desirous of obtaining catalogs and prices from American manufacturers on electric appliances and supplies, the number of this item being 23,926. Further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C., or any of its branches.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Generator Control--III

WESTINGHOUSE GENERATOR VOLTAGE REGULATORS; PROTECTIVE DEVICES

IN the voltage regulator built by the Westinghouse Electric & Mfg. Co., the main control magnet is energized entirely by alternating current supplied by the system being regulated, an arrangement said to free the regulator from the lagging influence of the exciter system and to eliminate the necessity of paralleling the exciters. Other features claimed for this regulator are its ability to handle an unlimited station capacity on a single control element, and its satisfactory operation on systems where extreme range of exciter voltage may be required.

Essentially, as may be seen by referring to the schematic diagram of connections, Fig. 16, this regulator

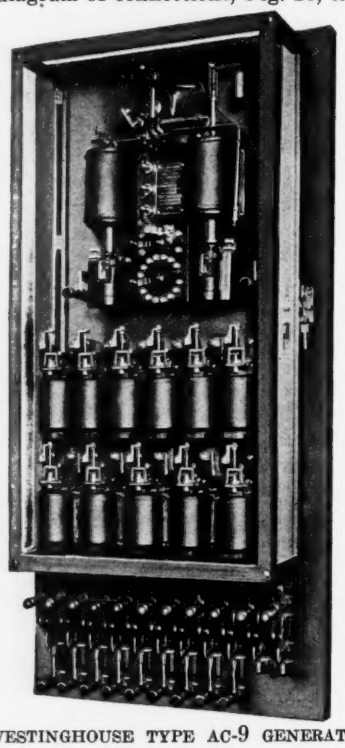


FIG. 15. WESTINGHOUSE TYPE AC-9 GENERATOR VOLTAGE REGULATOR

consists of a main control magnet, a vibrating magnet, a set of main contacts and two relays. The main control and vibrating magnets are of the solenoid type, are exceedingly sensitive and are provided with dashpots to permit adjustment of regulation to suit the characteristics of the system. Below these magnets are placed the two relays, the one at the right, the vibrating relay being used to govern the operation of the vibrating magnet; the one at the left is the rheostat shunting relay. Regulators of large size are provided with one or more master relays which control a group of rheostat shunting relays, thereby relieving the main contacts of handling control currents beyond their capacity.

The upper end of the core stem of the main control magnet is connected to one end of a counterweighted floating lever supported by a bell crank lever pivoted to the frame of the regulator as shown; the upper end of the core stem of the vibrating magnet is attached to the horizontal arm of this bell crank lever through the medium of a spiral spring. A counter weight is suspended at the extremity of this arm. Both main control and vibrating magnets are energized by the same voltage transformer, and actuate the movable main contact into and out of engagement with the fixed contact.

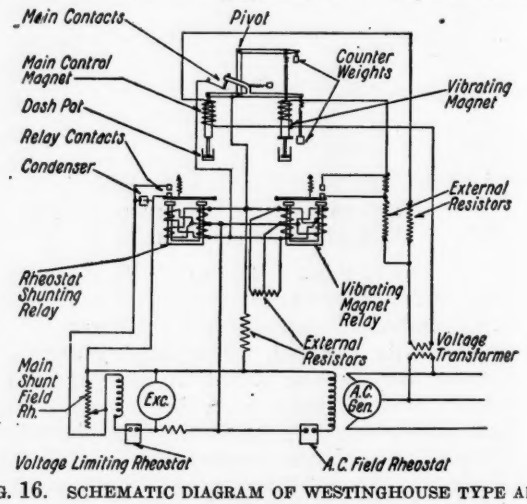


FIG. 16. SCHEMATIC DIAGRAM OF WESTINGHOUSE TYPE AB-1 REGULATOR

Due to the unique underlying principle of operation employed, a description of this may best be presented by quoting in substance a portion of such description as taken from literature issued by the Westinghouse Company on the subject. An inspection of schematic diagram, Fig. 16, shows that the closure of the main contacts causes all relay contacts to close. The vibrating relay is connected so that the closure of its contacts shunts a small portion of the resistance in series with the vibrating magnet, thus increasing its pull and opening the main contacts. This in turn opens all relay contacts and inserts the full resistance in the vibrating magnet circuit, weakening the pull and closing the main contacts again.

From the above cycle it is seen that for any given position of the floating lever, continuous vibration results. A necessary condition to the continuous vibration of the system is that the weight of the vibrating magnet core and lever must be exactly balanced by the tension of the control spring, and average pull of the magnet. Any change in the tension of the control spring results in an equal change in the average magnet pull. For a given line voltage there is a definite magnet pull when the contacts are closed, and a definite pull of less value when the contacts are opened. The average magnet pull must be a function of the time of the contact engagement. For any given position of the floating lever there is a corresponding position of the bell crank lever, and tension of the control spring; however, on account of the balanced condition there must be a corresponding

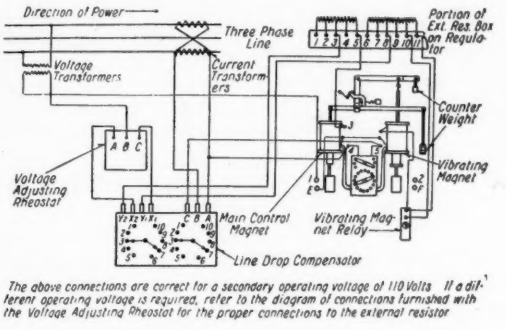

Direction of Power
Three Phase Line
Portion of Ext. Res. Box for Regulator
Voltage Transformers
Current Transformers
Counter Weight
Vibrating Magnet
Voltage Adjusting Rheostat
Main Control Magnet
Vibrating Magnet Relay
Line Drop Compensator
The above connections are correct for a secondary operating voltage of 110 Volts. If a different operating voltage is required, refer to the diagram of connections furnished with the Voltage Adjusting Rheostat for the proper connections to the external resistor

FIG. 17. CONNECTIONS OF REGULATOR AND EXTERNAL COMPENSATOR FOR 3-PHASE SYSTEMS

average magnet pull and time of contact engagement.

Rheostat-shunting relay contacts open and close across the shunt field rheostat of the exciter, and the effective resistance of the rheostat is determined by the time of contact engagement. For every value of effective resistance there is a corresponding value of exciter voltage, and, therefore, alternating-current voltage.

The time of contact engagement as here used, means the ratio of the time the contacts are closed to the total time for opening and closing.

As the control element is energized from the alternating current generator, the main control magnet will assume a position such that a time of contact engagement is maintained sufficient to develop an exciter voltage and, therefore, an alternating-current voltage capable of balancing the core weight. Any variation in line voltage changes the position of the floating lever in such a manner as to vary the excitation and restore the balance.

For self-excited direct-current generators, the rheostat shunting relays operate directly on the generator field rheostats, the control system being actuated from the direct-current mains through a suitable resistance. For direct-current machines having a separate exciter, the rheostat-shunting relays operate on the exciter rheostat the same as in the alternating-current regulators.

In the standard-range regulator, the rheostat shunting relays are energized from the exciter circuit; but in the broad-range regulator rheostat shunting, vibrating and master relays are energized from an independent source of direct current.

In Fig. 17 is shown a diagram of connections of Westinghouse regulator and external compensator for 3-phase systems.

EXCESS VOLTAGE PROTECTION

UNLESS REGULATORS of the types described are protected by some form of cutout relay or protective device, accidents such as are bound to arise in the operation of electric distribution systems may be the cause of much poor service and trouble due to an abnormal rise of voltage. An accident to the regulator may cause the relay contacts to stick and produce an exceedingly high exciter voltage; when a short circuit on the system is cleared, a dangerous voltage rise is inevitable. When a short circuit occurs and the regulator is not protected, the main contacts will close, causing the relay contacts to close and the exciter voltage to build up to maximum; and when the short circuit is cleared, the high exciter voltage and the accompanying high degree of generator field excitation cause the creation of an abnormal machine voltage which will continue until the regulator has had time to become operative again. Such effects are detrimental to the service, causing the destruction of lamps, heating devices and motors which at that time may be connected to the system.

Schematic diagrams of two forms of high-voltage cutout relays for use in connection with regulators as built by the General Electric Co. are shown in Figs. 18

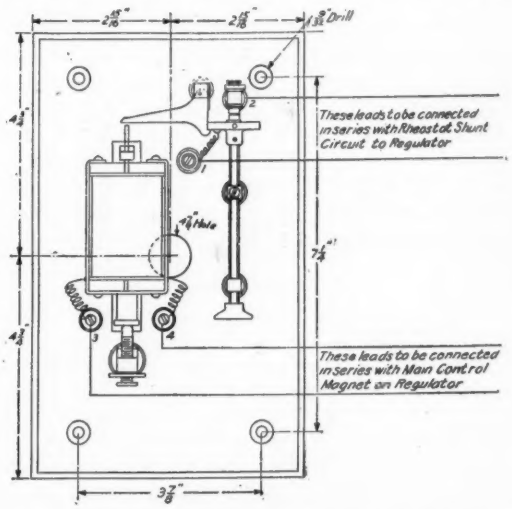

These leads to be connected in series with Rheostat Shunt Circuit to Regulator
These leads to be connected in series with Main Control Magnet on Regulator

FIG. 18. SCHEMATIC DIAGRAM OF GENERAL ELECTRIC CUTOUT RELAY WITH MANUAL RESET

and 19. In the former, the control magnet is connected in series with the main control magnet of a regulator having but a single relay, and the contacts are connected in series with the rheostat shunt circuit. A rise in voltage in excess of a predetermined value depending upon the setting of the thumbscrew causes the plunger to rise and trip open the contacts, which, opening the rheostat shunt circuit, inserts resistance into the exciter field and thereby reduces the generator voltage.

Excitation for the magnet in the other relay is obtained from a potential transformer or pressure wires; the two upper contacts are normally closed and as in the case of the other relay are connected in series with the rheostat shunt circuit to the regulator. Upon a sudden

rise in voltage, the plunger of the control magnet is drawn upward, resulting in the opening of the upper contacts and the rheostat shunt circuit and a decrease in exciter voltage. The effect of this action is to decrease the machine voltage which in turn will allow the control magnet plunger to resume its former position and close the upper contacts. This cycle is then repeated until normal conditions again prevail.

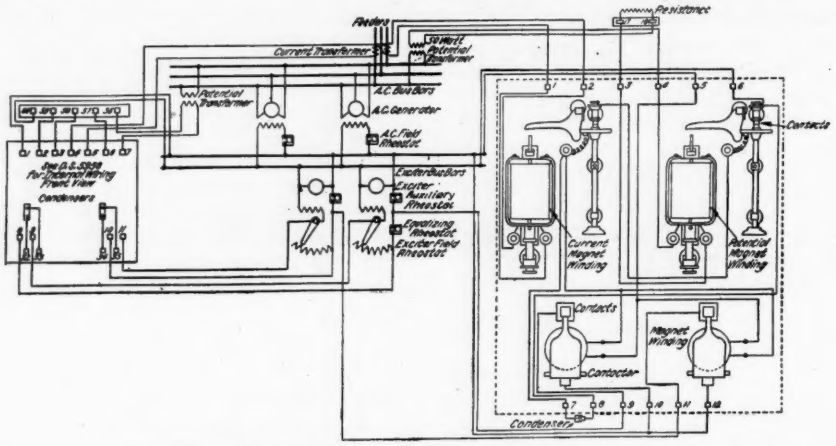


FIG. 20. CONNECTIONS OF HIGH VOLTAGE, HIGH-CURRENT CUTOUT RELAY WITH REGULATOR AND 2 EXCITERS IN PARALLEL

Another regulator protective device as manufactured by the General Electric Co. is that shown diagrammatically in Fig. 20. In this two relays are employed, one for current and the other for voltage and 1 to 4 contactors depending upon the number of exciters used in connection with it. Each contactor short-circuits an auxiliary rheostat in the exciter field and the coils of the contactors are connected in multiple and in turn across

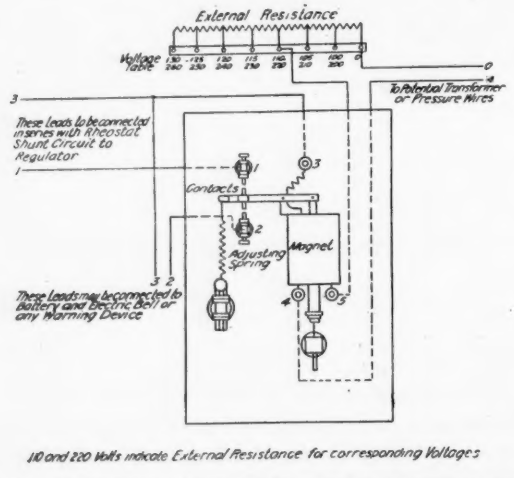

External Resistance
Voltage
To Potential Transformer or Pressure Wires
These Leads to be connected in series with Rheostat Shunt Circuit to Regulator
Contacts
Adjusting Spring
Magnet
These Leads may be connected to Battery and Electric Bell or any Warning Device
110 and 220 Volts indicate External Resistance for corresponding Voltages

FIG. 19. SCHEMATIC DIAGRAM OF GENERAL ELECTRIC AUTOMATIC REGULATOR CUTOUT RELAY

the exciter busbars through the contacts of the relays. Should there be a sudden rise in current flow, the current magnet opens its contacts, or should there be an abnormal rise in voltage, the potential magnet opens its contacts, either of which operations will open the shunt across the auxiliary rheostats and reduce the voltage to a point depending upon the setting of the rheostats.

A diagrammatic illustration of the excess voltage protective device employed in connection with Westinghouse alternating-current regulators is shown in Fig. 21. Essentially this device consists of a direct-current element energized from the exciter bus bars in combination with an undervoltage relay energized from the potential transformer supplying the alternating-current regulator. The relay contacts and those of the direct-current element are connected in parallel and as indicated, in series with the main contacts of the regulator.

The drop in voltage accompanying a short-circuit on the alternating-current distribution lines causes the main regulator contacts to close and the relay contacts to open. Closing of the main regulator contacts as noted in the description of the Westinghouse regulator causes all relay contacts to close, which we find by referring to Fig. 16, results in the short-circuiting of the exciter rheostat with the consequent building up of the exciter

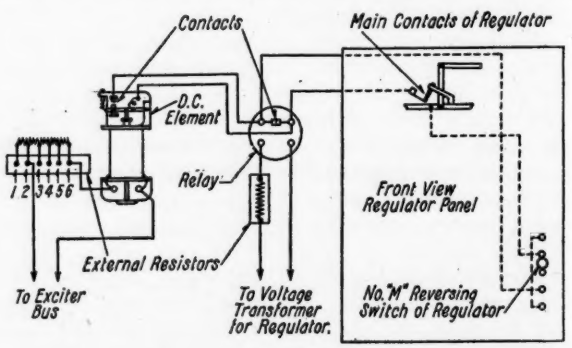


FIG. 21. DIAGRAMMATIC VIEW OF WESTINGHOUSE EXCESS VOLTAGE PROTECTIVE DEVICE

voltage. As soon as this voltage rises to the point for which the direct-current element is adjusted, the contacts of this element begin to operate and to regulate the exciter voltage in the same manner that the main regulator contacts normally do, thus preventing the exciter voltage rising above the predetermined point.

This is usually maintained a trifle above the no load excitation value required by the alternating-current generators. As soon as the short circuit opens the alternating-current voltage has a tendency to rise, but when it reaches a value corresponding to the setting of the undervoltage relay, the contacts of the relay close and place the regulator back into service.

(To be continued.)

Rules for Electrical Equipment in Mines

SUGGESTED safety rules for installing and using electrical equipment in bituminous coal mines, the preparation of which has been going on for nearly 3 yr., was undertaken by H. H. Clark and C. M. Means to encourage the standardization of safety measures for the prevention of electrical accidents underground.

The code is published by the Bureau as Technical Paper 138 and is the result of many conferences held by the authors with mining engineers, mine operators, the engineers of public service companies, and the manufacturers of electrical mining equipment. The rules have been revised many times at the suggestion of the conferees, and, as published, are said to meet with their approbation in almost every detail.

Mr. Clark, in discussing the paper, says: "The code is unique in some respects. The first step in its development was to establish five basic measures that would insure the use of electricity with safety and to use these as a basis upon which to formulate the rules. Each rule is proposed as necessary or helpful to the accomplishment of one or more of these measures.

"Especial attention has been given to making the code as complete as possible and to arrange the rules so as to facilitate consideration and reference. The authors have sought particularly to prevent the uncertainty, misunderstanding, and confusion that arise from incompleteness and from contradictory and conflicting requirements.

"Definitions have been established for an unusually large number of terms. Wherever these terms appear in the text they are 'starred' to direct attention to their definition.

"Some of the defined terms are the following:

"Approved: The use of this term makes it unnecessary to include in the rules detailed specifications which will give rise to complaint, misunderstanding, and endless debate unless given constant consideration and very frequent revision. The use of the term makes it possible to take immediate advantage of any meritorious equipment, methods, or practices that may be developed subsequent to the publication of the code. The indefiniteness that has been associated with this term and has discouraged its use is removed entirely by the definition which designates the approving authority clearly without restricting it.

"Switchboard — Underground Station — Portable Motors: These terms have never been defined in connection with mine electrical codes and a definition has been needed to dispel the uncertainty that has existed as to their exact meaning.

"Gaseous Place: This is probably the most unique and valuable definition that is offered. Of all the much debated questions relative to coal mines, probably none has received more consideration and has been less satisfactorily answered than the question 'What constitutes a gaseous mine?' The authors found that it was indispensable to the success of the rules to have a term that should designate a place in a mine where, on account of the presence of gas or the potential presence of gas, it was unsafe to operate electrical apparatus at all, or unsafe to operate unless it was especially constructed and safeguarded. After careful consideration, the term 'gaseous place' was selected to designate such a point in a mine. This term does not attempt to define a gaseous mine, a gaseous part of a mine, or a gaseous district in a mine, but merely a place in a mine that, on account of the presence or possible presence of gas, is an unsafe place to operate electrical apparatus. Such a place is defined as 'a place that is likely to be dangerous from the presence of inflammable gas.'

"It will, of course, be admitted by everyone that if a place is likely to be dangerous from the presence of inflammable gas electrical apparatus either should not be used there at all, or, if used, should be suitably safeguarded.

"There are a number of desirable requirements in these rules that either have not appeared at all in other rules or have not been emphasized there. Among these requirements is a table for the carrying capacity of bare copper conductors. While tables of this sort have been compiled in the past, the current carrying capacity assigned to the same wires has differed as much as 45 per cent, and the basis of reference was not in terms that were altogether applicable to the requirements of the rules. The bureau, therefore, undertook to establish the carrying capacity of bare copper wires in terms of the amount of current that such wires would carry without charring dry wood, burlap, and canvas brattice cloth pressed firmly upon the wire from a point about it. Tests were conducted to determine the amount of current that would produce positive charring for each wire examined. The current was then reduced until the charring was almost imperceptible and then, to introduce a factor of safety, 90 per cent of this latter current was established as the safe carrying capacity of the bare conductor. This basis appears to be a very practical one, since it will appeal to most people that a wire that is not hot enough to char wood is not a source of danger, while, on the other hand, a wire that is sufficiently hot to char wood cannot be regarded as a safe thing to have underground.

"Stress has everywhere been laid on good construction and installation, as it is believed that this alone will help a great deal to bring about safe conditions.

"Wherever possible reference has been made to standardized practices (those of the American Institute of Electrical Engineers and of the Underwriters) as, for instance, the name plate rating of apparatus and the carrying capacity of insulated wires.

"The general rules offered for the prevention of accidental contact strike at the fundamental causes of such accidents.

"The bureau solicits correspondence and criticisms regarding these rules to the end that they may be revised at suitable intervals in order to eliminate defects and provide modifications rendered necessary by the progress of the art."

Feed Water Control—IV

Concluding Descriptions of High and Low Water Alarms

ALL the operating mechanism of the Anderson safety water column is assembled as a single unit in a removable hanger from which it is secured to the interior of the column casting by means of hexagonal brass screws. Through a stem extending to the hanger frame, the whistle valve is opened by the movement of either float lever by means of bell crank connections. As the water level rises, the copper float strikes the upper lever causing the whistle valve to open, thus indicating the high-water limit. In the event of low water, the float falls to a point where it comes in contact with the lower lever which pulls on the whistle valve stem and sounds an alarm.

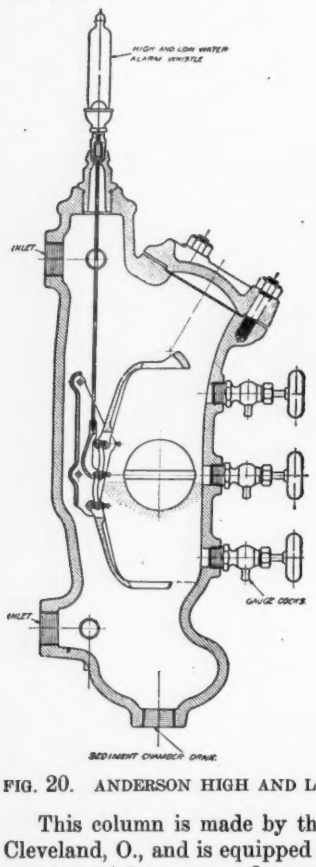


FIG. 20. ANDERSON HIGH AND LOW WATER ALARM COLUMN

This column is made by the V. D. Anderson Co., of Cleveland, O., and is equipped with the Anderson patent seamless high pressure float, made of spun copper and heavily reinforced.

Kitts Safety Water Column

In place of a hollow ball float, the Kitts water column is provided with a gravity weight and counterweight, mounted on compound levers which are attached to the cover of the column, as shown in Fig. 21. In normal operation the small weight on the long lever slightly overbalances the gravity weight when submerged, thus closing the valve to the whistle. As the water level drops in the column and leaves the gravity weight, that weight falls, and by pulling down on the compound levers the whistle valve is opened to sound an alarm.

This low-water alarm is made by the Kitts Mfg. Co., of Oswego, N. Y.

Eclipse Safety Water Column

Under normal operation the whistle valve of this column, which is made by the Illinois Engineering Co., of Chicago, is held closed by a weighted lever attached to the top of the column. Sliding down the center rod is a float, as shown in Fig. 22, which upon striking the predetermined high or low water limits operates a lever, pushing downward on the weighted lever, unseating the valve and allowing the whistle to blow.

Combined High and Low Alarm Column with Solid Weights

Operated by solid metal weights is a high and low water alarm column, as shown in Fig. 23, which is made by the Engineering Co., of Philadelphia. Each weight is suspended from a lever, one arm of which passes through a loop formed at the end of the whistle valve stem. Under normal operation the weighted arms hold the whistle valve closed, but should the water level fall away from the lower weight or rise around the upper weight, a direct or indirect pull is exerted upon the valve stem to sound an alarm.

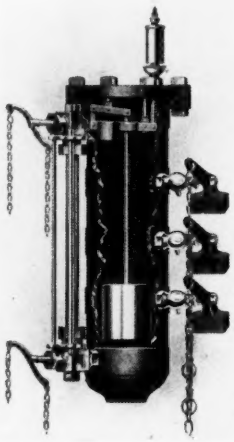


FIG. 21. KITTS SAFETY WATER COLUMN

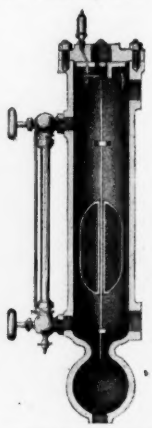


FIG. 22. ECLIPSE COMBINED HIGH AND LOW WATER ALARM

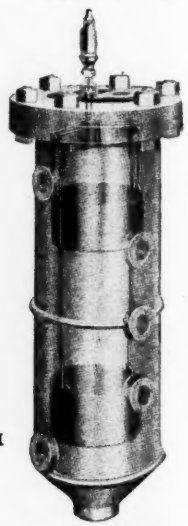


FIG. 23. SOLID WEIGHT ALARM COLUMN

Correction Notice

I would like to call the attention of the readers of Practical Engineer to a slight error in my article, Motor-Starting Resistances, page 231, of the March 1 issue. Starting with the first line, second column, page 232, we have, "This action, which is made slowly and smoothly, due to the oil dashpot, OL, closes the main circuit and energizes solenoid RR, causing its core to rise and move the contact arm, C, over the contacts."

This should read, "This action closes the main circuit and energizes solenoid RR, causing its core to rise and move the contact arm, C, over the contacts slowly and smoothly, due to the oil dashpot, OL."

Of course, it is apparent that the oil dashpot has nothing to do with the action of the solenoid switch, SS, which snaps into place the moment the controlling switch, D, is closed.

A. Edwin Wells.

Condemning an Engine

DEPICTING THE FALLACY OF PLACING COSTLY MACHINERY IN CHARGE OF POOR ENGINEERS. BY C. E. ANDERSON

THE MANAGEMENT of a combined water works and electric-light plant located in the southern part of Illinois wished to condemn an engine-driven, direct-current generating set, due to the fact, as was stated, that the builders had failed to meet all the requirements of the contract. It was claimed that the engine was too small and generally unsatisfactory in other ways, being a steam eater and a regular steam

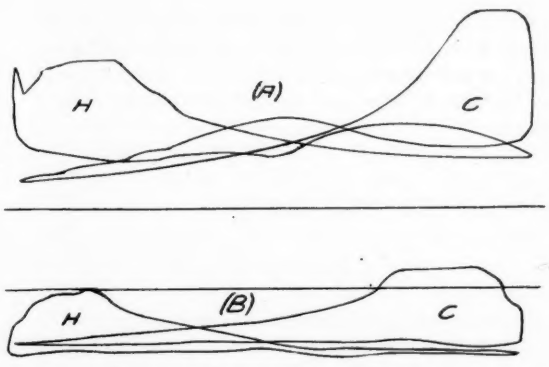


FIG. 1. CARDS TAKEN FROM ENGINE WHEN IN CHARGE OF "EXPERT" ENGINEER

hammer combined. All sorts of difficulty was experienced in keeping the engine keyed up, and other faults too numerous to mention.

As this engine was built by an engine manufacturing concern of high standing and reputation, these requests for condemnation seemed somewhat "fishy" to us.

From the data given, we found that the engine was of ample size to pull the load with some power left in reserve, and therefore came to the conclusion that there was evidently something wrong with the adjustments of the valve gear. In their original complaint, the lighting company stated that the engine worked satisfactorily for the first 4 mo., but since then had gradually been losing power until it could hardly drag ¾ of its rated load. This, in our estimation, indicated bad valve setting. We sent one of our men down to indicate the engine and the first mail brought the indicator cards shown herewith, justifying our contention.

The engine in question was of the Corliss tandem-compound single-eccentric type operating condensing, the eccentric was adjustable on the shaft by means of a set screw. After this set had been installed about 4 mo. the firm decided to change engineers, as in their estimation the man then in charge was getting too old to operate such "high-class up-to-date machinery." They hired a younger man who formerly had been engineer and general machinery wrecker in a coal mine nearby, and from the day he took charge of the plant troubles with the new generating set commenced.

Upon questioning the engineer (?) regarding his troubles with this engine, he replied that it was "all the engine's fault, as it was not built right; she had too many valves." A slide valve engine was the only kind of an engine, in his estimation. He was asked if he had ever indicated an engine. In reply he stated that he had heard of indicators, but did not believe in them, as they were intended only for "book engineers" and not for practical men like himself.

He set all his valves by trams and sound, and when asked how he trammed the valves on the Corliss engine, he replied that he "didn't exactly use the trams on her; he could tell whether the valves were set right by the way the pump rods (dashpot rods) worked," and if they did not work just right he "shifted the eccentric ahead or backward on the shaft just a little until the pumps worked right." There appears to be several ways of setting Corliss-engine valve gears, but this one was entirely new to me, and to use our troubleman's expression, "that guy's rule for setting Corliss valves is a peach," sums up the situation. The old saying, modified a trifle, "place the care of a $10,000 engine in the hands of a $10 man and the reputation of the engine is bound to suffer," certainly holds good in many cases and in this one especially.

In the evening when the full load or all that the engine could pull was on, cards numbered A and B, Fig. 1, were taken, A from the high- and B from the low-pressure cylinders respectively. They tell their own story of too long a reach rod and a misplaced eccentric. The engine was allowed to drag along until midnight, when the plant was usually shut down. After shutting down, the valves, the valve gear and the governor were adjusted and set to their approximate correct positions and the next morning, by means of a water rheostat (using the creek nearby), full load was put on the generator and the engine pulled the load very easily. After a few minor adjustments to the valve gear, cards C and D, Fig. 2, were taken, which were as good as could be

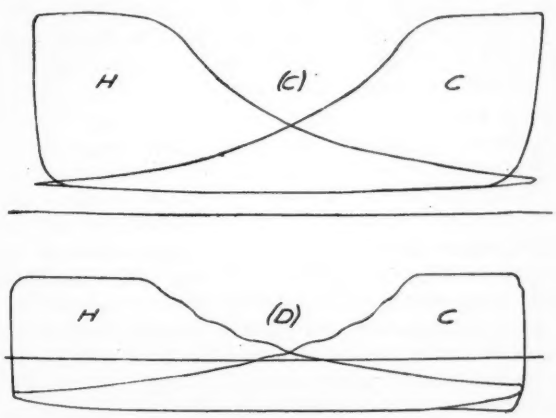


FIG. 2. CARDS TAKEN FROM ENGINE AFTER VALVES WERE PROPERLY SET

obtained under the circumstances, due to wear in the valve chambers. The engine was then pronounced O. K.

The general manager of the plant was well pleased and said among other things, "The engine now runs just as it did when the erecting man left it about a year ago." Of course, he wanted to know what the trouble was, and after he had been informed a messenger was hastily sent after the former engineer with an urgent request for him to come back to his old plant, which he accepted. The "Corliss expert" went back to the mines.

Operating Details of Gas Producers

INVESTIGATIONS CONDUCTED BY THE BUREAU OF MINES REVEAL MUCH INTERESTING AND VALUABLE INFORMATION

IN THE latest publication issued by the Bureau of Mines, Department of the Interior, and designated as Bulletin 109, Operating Details of Gas Producers, R. H. Fernald discusses the present producer gas plant situation and makes comparison between this source of power generation and the steam turbine.

The steam turbine, he states, has naturally lent itself to central-station service. It was a unit easily understood by steam-engine operators in so far as practical operation is concerned; it could be readily erected without radical changes in the boiler-room equipment; and it rapidly met the demand for large central-station units.

The producer-gas plant was an untried factor; it met with strong opposition from the older steam-plant operators, who saw possibilities of being forced out of their positions; its installation meant a complete renovation of the entire plant, with the replacing of the steam boiler by the producer unit. Large units of this type did not materialize, with the natural result that even today the producer-gas power plant is not the large central-station unit, although it occupies a strong position among the isolated plants and the small central stations.

Methods of operation vary greatly with local conditions and especially with the personal inclination or opinion of the plant superintendents and as yet no standards for comparison of plant operations have appeared and little has been known by the superintendent of one plant regarding the relative efficiency of operation of his own installation and that of another plant of similar type operating under similar conditions.

Several unsuccessful attempts have been made by various organizations to collect data relating to these important matters, but unfortunately little or no information could be had.

Appreciating the value of such data in connection with the many problems of fuel conservation and its investigations into the use of producer-gas power, the Bureau of Mines decided (1) that an effort should be made to procure operating details from a small number of representative producer-gas plants using scrubbed gas either for power or heating purposes; (2) that primarily data from plants using bituminous coals and lignites should be sought, but that data from a few of the larger anthracite plants and the oil and wood plants should be included.

With these points in mind, data sheets were sent to the owners of a limited number of plants; returns of a positive character were received from 39 installations.

An inspection of several plants in 1913 showed rather conclusively that on the whole the grade of fuel used in producer-gas installations has been steadily rising, and, in the main, the fuel used today is decidedly superior to that used 6 or 8 yr. ago.

Although from the standpoint of the engineers of the Bureau of Mines this condition is to be regretted, it is perhaps perfectly natural, as the tendency of the operators of such plants is to reduce manual labor to a minimum. A feeling of assurance by the management of guaranteed reliability of service is also commercially important in determining the quality of fuel to be used. It is not strange, then, that the highest grade fuel obtainable at a reasonable price is, in nearly every instance, the one adopted.

FUEL CONSUMPTION

ONE OF THE most important commercial items connected with the design and the operation of gas producers is the determination of the number of pounds of fuel consumed per square foot of fuel-bed area per hour. This rate of fuel consumption varies radically with different types of plants and with different grades and different types of fuel and has led to much difficulty in designing and in rating producers.

The average consumption of 7 of the plants reporting was, on the basis of the manufacturers' rating, 10.7 lb. per square foot of fuel bed area. The number of plants reporting operating figures for anthracite coal is not enough to permit the presentation of averages, although it is probable that the average figure for commercial operation for up-draft plants using anthracite as a fuel is not far from the average given on the basis of the manufacturers' rating.

For the up-draft plants operating on bituminous coal the range of actual operating rates of fuel consumption seems to be from approximately 6 to more than 13.5 lb. per square foot of fuel-bed area per hour. This marked difference might, on first thought, be supposed to be due to differences in the character of the fuels, but an examination of the records submitted shows that actually the higher-grade fuel is used in the plant reporting the low rate of fuel consumption per square foot of fuel-bed area per hour.

The coal used in the plant reporting the 6-lb. rate averaged 14,500 B.t.u. as fired and contained 5 per cent ash and 0.9 per cent sulphur, whereas the coal used in the plant reporting 13.7-lb. rate averaged 12,520 B.t.u. and contained 10.1 per cent ash and 3.4 per cent sulphur; the coal in the plant reporting the 13.1-lb. rate averaged 12,300 B.t.u. and contained 7.4 per cent ash and 0.5 per cent sulphur.

Although there seems to be little direct relation between the rated fuel consumption for the individual plants and the number of pounds of fuel actually burned per square foot of fuel-bed area, the average figures check within reasonable limits and indicate that approximately 8.5 lb. per square foot of fuel-bed area per hour with good-grade bituminous coal is a reasonable figure for an up-draft producer gas plant.

In the following table are figures showing the average fuel consumption per square foot of fuel bed area per hour for various types of plants and kinds of fuel and although too much stress must not be laid on the values given, deductions from typical operating figures coupled with personal observation of many other plants

seem to indicate them to be representation of good general commercial practice.

Kind of plant	Fuel consumption per square foot of fuel-bed area per hour with—							
	Anthracite coal		Bituminous coal		Lignite		Peat	Wood
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Average
Up-draft using—	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Fuel as fired	10.0	14.0	8.5	14.0	12.0	17.0	15.0	14.0
Fuel dry. . .	10.0	13.5	8.0	13.0	8.5	12.0	12.0	.....
Down-draft using—								
Fuel as fired	.....	.....	17.5	23.5	26.5	31.5	35.5	.....
Fuel dry....	.....	.....	16.5	22.0	18.5	22.0	25.5	.....
Double-zone using—								
Fuel as fired	.....	.....	13.5	18.5	21.5	27.0	.....	.....
Fuel dry....	.....	.....	12.5	17.5	15.0	19.0	.....	.....

Fuel Consumption

Producer-gas investigations of the United States Geological Survey and of the Bureau of Mines, conducted with plants not above the average in efficiency, showed the following approximate fuel consumption per brake horsepower per hour:

Condition of fuel	Fuel consumption per brake horsepower-hour with—						
	Bituminous coal			Lignite			Peat
	Average	Maximum	Minimum	Average	Maximum	Minimum	Average
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Fired.....	1.3	2.0	0.8	2.0	2.8	1.5	2.6
Dry.....	1.2	1.8	.8	1.63	2.02	1.35	2.0

Depth of Fuel Bed

This, as indicated in the following table compiled from data supplied by various producer-gas companies, varies considerably, depending upon type of plant, kind of fuel, the grate area and the approximate quantity of fuel burned per hour.

Plant No.	Type of Plant	Kind of fuel	Grate area	Approximate quantity of fuel burned per hour	Depth of Bed
			Square feet	*Pounds*	*Feet*
14.....	Up-draft.	Anth. coal	7.1	125	4
9.....	Up-draft.	Anth. coal	12.6	160	2.5
6.....	Up-draft.	Anth. coal	13.6	.....	3
36.....	Up-draft.	Anth. coal	44.2	200	6
32.....	Up-draft.	Anth. coal	38.5	.....	2.75
34.....	Up-draft.	Anth. coal	38.5	300	2
19.....	Up-draft.	Anth. coal	44.2	300	10
16.....	Up-draft.	Anth. coal	56.6	500	4
37.....	Up-draft.	Bitu. coal	23.7	165	2
3.....	Up-draft.	Bitu. coal	25.0	190	3
39.....	Up-draft.	Bitu. coal	50.2	300	1.5
25.....	Up-draft.	Bitu. coal	40.0	340	2.5
25.....	Up-draft.	Bitu. coal	50.0	425	2.5
21.....	Up-draft.	Bitu. coal	50.0	435	1.75
17.....	Up-draft.	Bitu. coal	33.1	450	4
5.....	Up-draft.	Bitu. coal	70.9	500	3
21.....	Up-draft.	Bitu. coal	78.0	680	1.75
12.....	Up-draft.	Bitu. coal	210.0	2,750	6.5
15.....	Up-draft.	Lignite	.....	.....	4
4.....	Up-draft.	Lignite	19.6	225	2
38.....	Up-draft.	Lignite	41.3	350	6.5
11.....	Up-draft.	Lignite	38.5	570	1.5
13.....	Up-draft.	Wood	50.3	605	8
26.....	Up-draft.	Wood	50.3	725	7
29.....	Down-draft.	Bitu. coal	.....	220	5
22.....	Down-draft.	Bitu. coal	17.4	250	5
27.....	Down-draft.	Bitu. coal	17.4	295	6
35.....	Down-draft.	Bitu. coal	20.4	300	12
28.....	Down-draft.	Bitu. coal	50.0	625	6
8.....	Down-draft.	Bitu. coal	36.0	1,200	8.5
23.....	Down-draft.	Bitu. coal	60.0	1,400	9
2.....	Double-zone.	Bitu. coal	29.3	310	12
31.....	Double-zone.	Lignite	.....	.....	8

Cost of Compressing Air

Coal, Gasolene and Electric Current Compared. By H. V. Conrad

In the contemplation of purchasing a relatively small air compressor unit, say 50 to 100 horsepower capacity, it is often desirable to consider various sources of power for operating it and the cost of fuel. Data given in the Practical Reference Tables have been compiled to show readily these comparisons wherein the air compressor is to be driven either by:

I. Steam Engine, direct connected or belt driven.
II. Gasoline Engine, direct connected or belt driven.
III. Electric motor, direct connected or belt driven.

It may be noted from the example given in each table that to compress and deliver 100 cu. ft. of free air at 90 lb. pressure,

I. The cost of coal will be..... 0.5232 cent
II. The cost of gasoline will be..... 1.08 cents
III. The cost of electric current will be 1.1 cents

when the cost of coal is taken at $6 per ton, gasoline at 22c per gallon, and electric current furnished by a steam operated commercial distributing plant at 4c per kilowatt-hour.

In using these tables it is, of course, necessary to assume certain figures suiting local conditions in order to make proper comparisons, after first determining the horsepower required to compress and deliver 100 cu. ft. of free air per minute and assuming the mechanical efficiency of all the machines is about the same:

In Table I, the steam consumption of the engine must be approximately determined. In the example, it is taken at 34 lb. per horsepower per hour; if it were 17 lb., the cost of coal would be ½. The boiler evaporation in the table is given as delivering to the engine 7 lb. of water for each pound of coal burned, and any percentage of variation from this performance should appear in the calculations. When the final figure of cost in the table is determined, it must be multiplied by the cost of coal in dollars per ton. A steam driven compressor requires boiler power, and the cost of this and the expense of operating it must be considered, when comparing with other sources of power, aside from the cost of coal which latter is covered by the table.

In Table II, the gasoline consumption per brake horsepower will not vary greatly, but the percentage of variation should be considered. If kerosene or other oils are burned instead of gasoline, the price per gallon should be determined, also the consumption per brake horsepower.

In Table III, it is assumed that the consumer may wish to buy electric current from some power plant.

The figures in all the tables are given in multiples so that missing ones can readily be determined; for illustration, if 100 cu. ft. of free air requires 10 hp., ½ the horizontal column of 20 or ⅓ of 30 can be taken. If gasoline costs 20c, multiply by 2 the column given under 10c. If electric current costs 6c, multiply by 2 the column given under 3c.

These tables can be used to advantage in considering a plant of any size or efficiency.

Note.—In the cost figures the element of time need not be considered in compressing 100 cu. ft. of air, whether it requires ¼ min., ½, etc., to do the work.

Wire Rope Tackle*

USE OF WIRE ROPE FOR HOISTING; HANDY CHART FOR QUICK COMPUTATIONS. BY W. F. SCHAPHORST

DATA recently published by the John A. Roebling's Sons Co., of Trenton, N. J., who have given me permission to use their interesting and useful information on this subject, is the basis of the computing chart appearing in the Practical Reference Tables of this issue.

Simply lay a straightedge across the chart once, as indicated by the dotted line, and column B immediately gives the pull necessary to lift any weight up to 200,000 lb.

For example, what pull on the lead line is necessary to lift 20,000 lb. with 5 ropes leading to and from the moving block?

Connect the 5 (column A) with the 20,000 (column C) and the answer—about 4700 lb.—is found at the intersection with column B.

This chart takes into account the friction of the ropes and pulleys. The smaller the number of ropes the less the friction, but the greater the number of ropes the less the pull on the lead line. Quoting verbatim from the Roebling publication:

"In the field of construction and engineering, tackle using wire rope has largely supplanted those using manila rope. Such tackle ropes as used on derricks, hoists, etc., are reeved with a number of parts using single or multiple sheave blocks.

"The number of parts supporting the load is determined by counting the ropes leading to and from the moving block. To arrive at the stress on the lead line, common practice is to divide the weight of the load by the number of parts of rope supporting it; this, however, is not correct, as it does not take into account the friction of the blocks nor the rigidity and internal friction of the rope.

"The maximum stress, when hoisting, occurs in the lead line, since this part besides taking the proportion of load on a single part, also takes the accumulated friction of blocks and rope in all the other parts of the tackle.

"To show the error arising in assuming all parts of rope in a tackle taking equal proportions of the load, we give an example of a 7-part hoist raising a load of 35,000 lb. Usual practice for stress in lead line is $35{,}000 \div 7 = 5000$ lb., and assuming all parts pulling equally. This stress occurs, however, only in the becket line. The correct method for maximum stress is $35{,}000 \times 0.1807 = 6325$ lb. (this may be checked on the chart. W. F. S.) were 0.1807 is the lead line, pull factor for a 7-part tackle. This stress of 6325 lb. occurs in the lead line only and is 27.5 per cent greater than the value found by the first, incorrect method.

"If a rope were to have been chosen on the basis of the 5000 lb. stress with a factor of safety of 6, this factor of safety would in reality have been only 4¾ with the resulting stress of 6325 lb. In many cases, contractors do not use such a large factor as 6 to start with, and hence the actual factor is reduced in proportion and short rope life results, frequently causing dangerous and costly accidents.

"The ropes usually used in construction work are 6 by 19 construction and blue center steel quality, though plow steel can be used if the stress is within the limits of this quality. The ropes range from ½ to ⅞ in. diameter, inclusive, with the ropes included in the above requirements and with the tread diameters of the sheaves in the blocks not less than 20 times the rope diameter."

*Copyright, 1917, by W. F. Schaphorst.

Volume of a Cone-Shaped Coal Pile

WHEN it becomes necessary to calculate the volume of a cone one naturally calls upon his memory for the formula; if that fails he resorts to reasoning from first principles and if that doesn't come quickly he turns to a hand book containing the formula, then he finds that the volume is equal to the area of the base times one third the height. Nobody ever measures the area of a circle, he measures diameter; so he turns to another page in his hand book to find the area of the base of his cone. Having secured this information, he proceeds to multiply and divide.

Why not save this strain upon the memory and the mental friction of mathematical calculations, and at the same time reduce the time for making the calculations down to—well—20 seconds to be conservative? Turn to the Practical Reference Tables of this issue where a chart is presented for just this purpose.

Enter the chart at the proper point in the scale marked "Height, Ft."; trace horizontally to the vertical line representing diameter of base in feet. The junction of these 2 lines is on or near one of the diagonal lines representing contents in cubic feet, which is the information desired.

Take, for example, a cone 6 ft. high and 24 ft. in diameter at the base, tracing as described above we read the contents as 900 cu. ft. closely. By calculation we get 904.8.

Another cone is 16½ ft. high and has a diameter at the base of 62 ft.; by the chart we estimate the contents to be 17,000 cu. ft.; by calculation it would be 16,938.383+.

The practical use of this chart around power plants is in determining the amount of coal in a pile as it naturally forms itself on the ground when being discharged from a chute or grab bucket. According to one authority, the natural cone of anthracite coal is 0.25 as high as it is in diameter at the base, bituminous is 0.36 and coke 0.42. These lines have been plotted on the chart so that knowing one dimension of the natural cone pile of coal and tracing it to the proper slope line the contents in cubic feet may be closely approximated.

To find the weight of the coal in the pile turn to the table on the back of the chart in the Practical Reference Tables where the weight in tons for various volumes of different kinds of coal is given.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

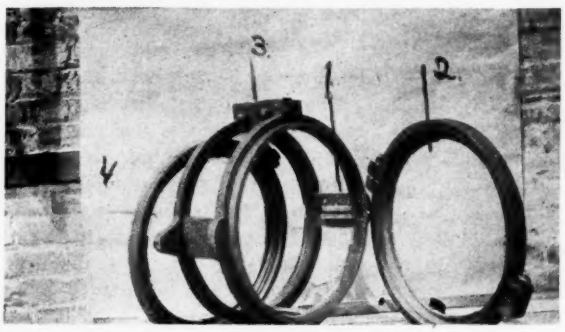
Repairing a Crankpin

REPAIRS to the crankpin of a large center-crank Corliss engine became necessary and for various reasons it was decided to turn down the old pin rather than stand the expense and loss of time incidental to replacing it with a new one.

A tool for turning down the pin was made as shown in the accompanying photograph. The entire set was cast, then cut in two and bolted together before being machined.

Four bearing points were left on the inside edges of each of the 2 outer rings, 2 and 4, and the rings clamped to the crankpin with their backs against the crank discs and the center part of the tool, 3, between them.

When properly set up, the large ring, 3, could be turned, without end or side motion, by means of a short



PARTS OF DEVICE EMPLOYED IN TURNING DOWN CRANKPIN

lever inserted into an opening where the 2 halves are bolted together. The cutting tool was carried on a block working in an under-cut groove on the inside of the large ring. A cap screw, not shown, was screwed into the back of the block and extended through a slot in frame. The head of this screw was drilled and tapped parallel to the line of travel for a lead screw with star feed which was carried on 2 lugs similar to those shown on the front side. The star feed was operated by a spike driven into a piece of wood and fastened to the engine frame.

As the bearing points of the two outer rings were only 3/16 in. thick, it was a small job to file down that portion of the pin under the bearing points that the tool could not reach. One man with a 3-ft. lever was able to work the tool, but on account of the size of the discs 2 men were used.

After the bearing had been finished and refitted, it ran quietly and without heating with considerable overload.

A number of improvements could have been made had circumstances allowed, but it did what was required in a very satisfactory manner. SUBSCRIBER.

Peculiar Cylinder Wear

UPON OPENING up the high-pressure cylinder of a large Wetherill cross-compound engine the other day, we discovered what I consider a peculiar and unusual case of wear in the side of the cylinder. Aside from being badly scored with deep straight grooves for the entire length of piston travel and entirely around the cylinder, we found the side walls quite hollow midway forward and the top half of the crank end of the cylinder worn very deep and ending in a 3/16-in. shoulder at the end of the piston travel which extended around down to the center of each side right next to the counterbore and upon reboring we found it necessary to take 3 cuts through the cylinder and then didn't get the depression all out.

Naturally, a discussion arose as to the probable cause of the peculiar manner in which the cylinder was worn, as the greater wear under all ordinary conditions is looked for on the bottom and for the greater part of the entire length of the piston travel.

One fellow said that on account of the piston packing rings being made up of short sections he thought that might have something to do with it. Another thought that the trouble was caused by the piston rod packing being made up of sectional metallic rings enclosed in the usual case and consequently more rigid than soft packing. Still another concluded that when the piston reached the crank end of the stroke together with the fact of the piston reversing its direction at this point caused the piston to pound against the top half of the cylinder and make the peculiar shoulder and groove, and this seemed plausible, for upon examination we found as a third cause that the crosshead was quite loose in the guides and this would bring the effects spoken of during sudden changes of load. However, we all know it is customary to allow some clearance between the top shoe and top guide on all engines having bored guides, yet we all know that too much clearance there will cause unnecessary noise at times which is bound to be accompanied by more or less unusual wear upon the crosshead guides and also the cylinder walls.

The machinist who did the boring and who has had an extensive experience in boring cylinders advanced the idea that all cylinders using high-pressure steam are usually worn more on the top than on the bottom. But why so? The steam pressure in this case was 175 lb.

The chief engineer thought that the steam pressure entering through the top ports would have a tendency together with the weight of the piston to hold it to the bottom of the cylinder, but the condition of this cylinder knocked that idea into a cocked hat.

I would like to hear the opinions of other men who have had experience in reboring cylinders and in notic-

ing the different ways in which they find the cylinders worn.

Another thing about this job that "got my goat" was the refusal of the chief to allow us to pull the exhaust valves and the crank end steam valve in order to watch the working of the boring bar in the crank end of the cylinder. Instead, we were instructed to crawl in and make our observations and to stuff the two exhaust ports full of rags and waste to take care of the borings: also that when we had finished and went to clean up that what borings didn't come out with the rags and waste could be fished out with a magnet. A fat chance of getting the borings all out if the exhaust valves were worn in their seats, as is usually the case after an engine has been in service 4 or 5 yr.

The bull ring of this piston, which is 12 in. long, had two packing ring grooves 1¾ in. wide, cut 1¾ in. from each end and midway between these were 2 inlaid composition rings running entirely around the piston, which showed no apparent wear, while the sectional packing rings were found to be much worn and to have very sharp ragged edges; so we concluded that the sectional packing did have something to do with it, and here arises the question as to which is the best, all things considered, the sectional piston packing rings or the ordinary ring with only one opening.

MACHINIST.

Why Didn't the Generator Generate?

AMONG the many causes which may make a generator fail to generate, loss of residual magnetism is one of the most prominent. The magnetism that remains in the frame of the machine after the field current is cut off, is called residual magnetism, and every direct-current generator must have a certain amount of this to build up its field.

As a rule, dynamos leaving the factory retain enough residual magnetism to start on, but there are several ways in which they may lose it.

In many cases, the peculiar action cannot be explained; in some cases it may be due to any of the following conditions: (1) Excessive vibration. The machine should always rest on a solid foundation, preferably brick or cement; (2) To the earth's magnetism. This is very weak, but if assisted by vibration it may be sufficient to destroy the residual magnetism in the dynamo. Only 2 pole machines can be really affected this way, as on multipolar machines the poles radiate in all directions; (3) If a dynamo is placed in close proximity to another machine stray lines of force may thread their way through the magnetic circuit of the idle one in the reverse direction, and thereby neutralize its residual magnetism. (4) If the fields are accidentally given a slight flow of current in the wrong direction; this can very easily occur on a compound wound or series wound dynamo, as current from the outside will always flow through the series coils in the opposite direction to that in which the current from the machine itself would flow. In shunt machines, however, this is not so, for like a shunt motor, the field winding shunts both the armature and the line. (5) If the dynamo started up with the fields or armature as a whole incorrectly connected, that is, reversed, the result will be to destroy whatever residual magnetism there may have been. (6) The field circuit broken too suddenly; when a field circuit is suddenly broken, the residual magnetism is sometimes brought down to zero, or even reversed.

Where a dynamo has lost its residual magnetism, the pole pieces will have little or no attraction for a piece of soft iron. There are several ways by which the charge as it is sometimes called may be restored. Series dynamos seldom lose their charge so completely that they will not build up a field on a short circuit. Where a compound-wound generator refuses to build up with its shunt winding, it can often be made to do so by disconnecting the shunt coils and short-circuiting the generator through a small fuse, one that will prevent damage due to the short circuit.

Almost any generator can in many cases be made to build up a field by simply short-circuiting the armature by holding a piece of copper wire across the brushes, or by rocking the brushes back from their neutral position. The effect is to make the magnetism of the armature help the field to build up.

If none of these expedients produce the desired result, the fields must be recharged from an outside source. If the generator runs in parallel with other machines this is an easy matter; it is only necessary to lift the brushes or disconnect one of the brush holder cables on the dead machine and throw in the main line switch, the same as if the dynamo were going into service with the others. The fields will then take a charge from the line and their polarity will be correct. After the field has been recharged, the brushes or cable must not be put back in place until the main line switch is opened, because by so doing, a short circuit will be created. If the dead machine does not run in parallel with another dynamo and there is a live dynamo near, disconnect the shunt field from the dead machine and connect it to the live circuit. If there are absolutely no other available means for charging several ordinary cells of battery can be used, connecting the field coils and the cells in series. If this fails, reverse the terminals of the battery and repeat the operation. It may be that the first time the battery is applied its magnetizing force opposes what little residual magnetism there may have been in the field.

As a last resort connect the field so as to obtain the least possible resistance, put them in series with the armature, and run the armature considerably above speed. Very often a generator instead of losing its charge will acquire one of a reversed polarity, due, perhaps, to the same causes, exercised to a greater degree. There are several other causes which may make a generator fail to generate, but the article "Why didn't the generator generate?" quite decided that the cause was loss of residual magnetism, which seems, under the circumstances, to be a little puzzling, although it may have been caused under such a condition as outlined in (6) of this article.

WILLIAM T. ESTLICK.

WHENEVER a machine refuses to build up as N. N. Bava-Adam tells about on page 271 of the March 15 issue, I carefully examine all contacts and connections, see that the machine is O.K. mechanically and then, if the trouble is not found, go to the rheostat, where frequently poor contact between the arm and segments

will be discovered. To test the rheostat, I take a wire and touch lightly the terminals, a remedy which I have often applied to machines refusing to build up. I wish to warn against doing this, however, when the machine in question is already carrying a load.

Of course, a machine may also be prevented from building up, due to poor brush contact brought about by oil or grease on the brush faces, or the brushes sticking in the holder, the oil or grease causing a high resistance of the contacts.

If, however, all contacts and connections are clean and tight and the rheostat O. K., the trouble should be recognized at once as one of an electrical nature, undoubtedly loss of residual magnetism.

To cause a generator to pick up in this case, I take a piece of insulated wire and having stripped the ends, connect one of them to a + brush connection and lightly and quickly touch the other end to a — connection. Care should be taken doing this, as it is practically a short circuit and wonderful things may happen if a person lets both ends make solid contact; a light fuse wire on one end is not a bad idea if a fellow feels nervous. J. C. LEE.

[The practice of short-circuiting electrical machinery as related by Mr. Lee is one not to be recommended, and while he may luckily have been successful in bringing about the results desired, procedures of this nature tend greatly toward damaging the machine or apparatus and possible serious injury to the operator.

When you are certain your machine has lost its residual magnetism, the most approved manner of restoring this is by exciting the field windings from some external source of current supply, being careful that the flow of this current is in such direction as to establish proper polarity of the field poles. EDITOR.]

Discharging Electrolytic Lightning Arresters

ON PAGE 171 of the Feb. 1 issue, I noticed an answer stating that an electrolytic lightning arrester does not retain a charge and therefore does not require discharging before opening it for inspection or repairs.

From my experience, this answer is not correct, as it is often found that a charge is retained. The thin insulating film of aluminum hydroxide between the conducting aluminum and the conducting electrolyte acts as a dielectric and the tank is therefore an electrostatic condenser.

I do not know why the tank occasionally does not retain the condenser charge, unless it is due to the direction of the electromotive force through the tank at the time the arrester is disconnected. Usually, however, upon grounding the top terminal of the tank to the copper strip connecting the tanks together, a sharp discharge is obtained.

This grounding should be done on each tank separately, using a piece of insulated wire, cleaned at both ends, with a hook bent at one end. By hooking this end under the copper strip and touching the top terminal at the bushing, being careful to keep the hook in good contact below, the charge will be dissipated.

H. W. G.

MORE OR LESS difference of opinion appears to exist as to whether electrolytic lightning arresters require discharging by grounding before opening for inspection and repairs. Following are the opinions of two authorities on the subject.

In the design of the standard (General Electric) arrester, there are generally 4 sections of cones, each enclosed in a separate tank. These tanks are insulated from the ground so that the rack and tanks are at some intermediate potential between line and ground, depending upon the electrostatic balance of the system. Therefore, before opening an arrester for inspection or repairs, all live parts of the arrester should be discharged to ground. This is best accomplished by grounding the rack and the terminals connected to the stacks themselves. On higher voltage systems it is well to have the 3 lines leading from the horn gaps connected to ground during such times as these repairs are being made.

GENERAL ELECTRIC CO.,
V. E. GOODWIN.

WHILE it is true that the film of aluminum hydroxide on the trays of an electrolytic lightning arrester forms a condenser, the film is also a resistance. From an electrical standpoint it may be considered as a resistance and a condenser in parallel. As a result of this, whatever charge may be on the condenser after a charging of the arrester, or after a lightning discharge, will leak through the resistance. Therefore it is not necessary to dissipate the charge as suggested, for the reason that there is nothing to discharge. The same is also true of static electricity. The amount of static which might accumulate would be small and should leak away rapidly.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.,
F. S. PERKINS.

[It may be of considerable interest and value to readers of Practical Engineer to hear from some of their brother engineers whose duties embody the care of such arresters. Any acceptable comments or suggestions relative to the subject under discussion will be published. EDITOR.]

Burning Fuel Oil

IN THE USE of fuel oil, the writer has found a wide range of opinions among engineers regarding the most desirable pressure at which it should be delivered to the furnace.

Experiments have been made by the writer with pressures ranging from 5 to 125 lb. to the square inch.

On the extreme low pressure, the regulation of the fire is found to be more difficult; while on the higher pressure the regulating valve must be so nearly closed, at times, that there is a tendency for it to become clogged.

The best results were obtained with a pressure of 15 lb. to the square inch for all loads ranging from 10 to 140 per cent of boiler rating. J. M. ROW.

Card Criticisms

FROM A STUDY of diagram 3, page 279 of the March 15 issue, I would judge that if Tom Jones would have his release occur a little earlier and cut down on his compression a trifle, he would get better results.

W. S.

Bursting Elbow Causes Fatality

I AM MUCH INTERESTED in E. C. Smith's article, Bursting Elbow Causes Fatality. It seems to me that this was another case of the patent medicine kind of mechanic who is ready to install anything from a conductor pipe to the piping of a steam boiler and allow about the same amount of expansion.

Now, then, what provision was allowed, if any, for expansion? Also were the elbows of the three boilers in direct contact with the intense heat without being covered in some way? Was there an investigation as to the direct cause of the fatal accident? If there was, what was the verdict?

What I cannot understand is how the unfortunate brother engineer got scalded if the blowoff cock was on the other side of the wall, as the article states that the blowoff from the boilers was 4 in. to the outside of the wall and then reduced to 2 in., as the blowoff valve was a 2-in. asbestos packed cock.

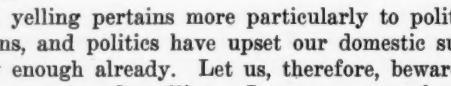
E. C. Smith should give the readers of Practical Engineer a clearer report on such an important matter. I surely agree with the Editor that under no circumstances should there be used anything but extra heavy pipe and fittings on any connection to the boiler or from the boiler. I think, if the *competent* help had been called in when the blowoff was installed instead of to help repair it, our brother engineer would still be on the job.

I think a blowoff pipe should never be reduced, but increased, if anything. ENGINEER.

Don't Yell

JACK L. BALL, on page 124, Jan. 15 issue, explains how accustomed to yelling he becomes during a sugar campaign.

Now, yelling pertains more particularly to political campaigns, and politics have upset our domestic sugar industry enough already. Let us, therefore, beware of contagion as regards yelling. In every sugar factory where I have had charge, I have made it a rule upon which I absolutely insist that there shall be no shouting around the mill. Consequently, if a man ever gets caught in a belt or otherwise has cause to yell, we run to his assistance instantly; and should it prove to be a



DANGEROUS BELT JOINT

false alarm, I personally see that he receives cause to yell.

The static in the belt under discussion recalls a gash I once got in the head under similar conditions. This belt was in a plant where I was a newcomer, and its first effort lifted a section of my anatomy large enough for a sucrose analysis.

That night I took the belt down, and found the missing pieces of myself adhering to a joint similar to the sketch.

This I forthwith changed to a rawhide lacing. Why, in the name of all the gods of safety, was such a man-trap ever invented? H. K. SCHOLEFIELD.

Fortitude of a Night Engineer

IS IT good policy to heap labors on the night engineer? Perhaps some may say it's a good idea in order to keep him awake nights, while still others may have a different view of the question. Some night engineers act as night watchmen ringing up each hour. The writer had a night job one time, but was not asked to carry a time clock. Among other duties incidental to a run-down plant, the following is a duplicate list which was posted up in the engine room for me to follow. (A copy of which I preserved upon leaving the job.)

DUTIES OF THE NIGHT ENGINEER

6:00 p. m.—Report for duty and inspect all machinery and boilers.

7:00 p. m.—Close service court gate and door of garbage house.

7:30 p. m.—Pull switch on service elevator and ash hoist. Clean elevator rooms and motors, sandpaper automatic switches. Turn on lights at 110th St. gate at dark and off at daylight. Wash filters 2 and 4 every day after 1:00 a.m. and 1 and 3 every Monday at same time.

Before washing filters close down on valve at 109th St. meter so that vibrations will not disturb the patients or the excessive speed injure the meter. Have fireman clean tubes on one boiler every night and keep boiler room clean.

See that all fuel is correctly weighed and recorded.

Read and record feed water meter at 12:00 p. m.

Read and record ammeter and steam gage every hour and note if live steam is on half.

Read and record at 8, 12 and 4 a.m. outside thermometer, high and low pressure gages and brine pressure. Also note pumps and compressors in service and time of starting and stopping compressors.

Inspect heating and ventilating motors every 2 hr. when running and see that the temperature of the house is kept at the proper point.

Open service court gate for the baker, also the basement door.

Relock basement door; 5:00 a. m. close switch on service elevator.

Open blowoff valves on boilers in service every morning long enough to clear the pipes of scale and dirt.

Read and record the temperature of kitchen refrigerator every morning as soon as open.

Do any work called for by the night superintendent of nurses when signed requisition is presented.

If work is of an emergency character it may be done on verbal order, but the written order must follow.

The Morgue must not be opened for the removal of a body without a written order dated and signed by the night superintendent.

Clean engine and generator in use during the day time.

Between 7 p. m. and 6 a. m. no one is to be permitted to enter or leave the building except through the main entrance on the first floor.

Record all happenings of interest or importance.

.....Chief Engineer.

JAS. G. SHERIDAN.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Indicator Card Criticism

THE DIAGRAMS shown herewith were taken from fore and aft 19 and 37-in. by 28-in. compound engine operating at a speed of 95 r.p.m. and under a steam (boiler) pressure of 85 lb. and a vacuum of 27 in.; the receiver pressure varied from 2 to 3 lb.

I wish you would kindly tell me:

(1) The cause of the back-pressure lines not coinciding.
(2) Why the head-end card is so much smaller than that of the crank end.
(3) The cause of the rapid drop in pressure at B. and the notches in compression lines at A and C.

I know the reducing motion employed is not entirely correct, but it does not appear to me as if this should be the cause of the defects indicated. Motion is taken from the air pump beam driven by links from the low-pressure crosshead, about 15 ft. of cord being used over 2 pulleys, with cord leads at right angles.

My idea is that notches A and C are caused by leaky piston, and small head-end card by insufficient lead; but as cards taken from this cylinder some time ago do not show the drop at B, I fail to understand this.

SUBSCRIBER.

A. The cards submitted from your 19 and 37 by 28-in. compound engine present some unusual features, a combination of which is not generally found in the same engine.

(1) The difference in back pressure at D sometimes occurs through partial obstruction of the exhaust passage from that end, and while the steam may enter the cylinder readily, it is not so prompt in finding its way out. And again, a slight disarrangement of the valve, due either to change of adjustment or possibly to wear, would cause a partial restriction of the ports for the exhaust from that end. The change of adjustment might not have been made intentionally, but in all probability was caused by "taking up" on wedges of keyheads in valve-gear or adjusting eccentrics (if used) or other means of valve propulsion.

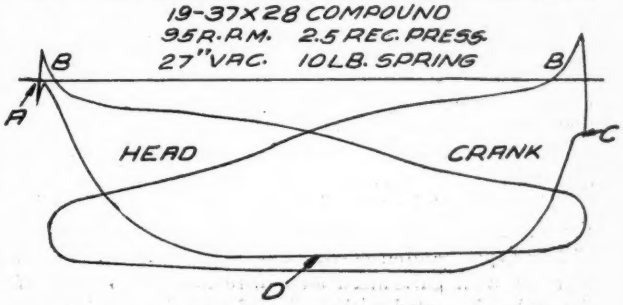
(2) While it is generally advisable to have the crank end card of a vertical engine a little the larger to compensate for weight of reciprocating parts above that of the counterbalance of the cranks, yet this difference should not be carried to extreme. Resetting the valve so as to bring the 2 ends more nearly equal will remedy the trouble, in the meantime watching the engine in operation for balance to "see how she runs."

You will notice that the admission lines lean toward the card slightly, whereas they should be at least vertical, or leaning slightly from the card, depending somewhat on speed, steam pressure and service.

(3) The rapid drop in pressure at B is undoubtedly due to a leak, or leaks, and with a very low initial pressure of 2 to 3 lb., such as you carry, it does not take much of a leak in the piston or valve to permit enough steam to find its way rapidly into a 27-in. vacuum. Indications are, by the similarity of the hooks at A and C, that the principal leak is in the piston, though the valve shows some also. It may be a broken piston ring, or just a loose one, while the valve may not be more than scratched or scored heavily or warped owing to possible changes in temperature due to change in steam pressure.

If the valve and piston are tight, the card would "carry out" better above the atmospheric line, and expand gradually to a low terminal pressure as it should. The terminal pressure now is much too high and represents a loss both in power and speed, other conditions remaining the same.

While your method of connecting the indicator cord may be all right so far as proper motion is concerned,



UNUSUAL CARD TAKEN FROM 19 AND 37-IN. BY 28-IN. COMPOUND ENGINE

yet the cord will show some variation in length, even if it be of the so-called "pre-stretched" kind. The cord should be as short and direct as possible. Try to arrange a light but rigid arm from the crosshead so as to obtain this if you can; if that is not possible, use light steel wire that will readily pass over the pulleys. A pendulum motion might be rigged up, also.

G. H. WALLACE.

Grinding Safety Valves

WHAT WOULD BE the best way for me to grind the disc and seat of a 4-in. Crosby Massachusetts Standard Safety Valve? H. L.

A. We presume that you have a Crosby safety valve which leaks. If so, the condition of the valve seats may be such that they require treatment other than ordinary grinding. If the seats are deeply scored, the only way by which this defect can be removed is to refinish or reface the seats. This can only be done on a lathe, an operation familiar to any machinist. If, however, ordinary grinding will suffice, this can be accomplished with

the valve remaining on the boiler; it is necessary only to remove the top or bonnet, together with the spring. The disc is then accessible, and by the use of sand or emery mixed with water or oil, preferably the latter, the two seats can be readily ground together in the usual way. It is important, however, that the seats shall not be ground down to the extent of bringing the lip on the disc in contact with the lip on the seat. Between the lips there should always be a slight clearance, sufficient to allow the insertion of a piece of ordinary writing paper. Without this clearance the valve cannot be satisfactorily regulated.

CROSBY STEAM GAGE & VALVE CO.,
C. H. MILLETT.

Underground Steam Line Covering

WHAT IS the best covering for an underground steam line having a length of, say, 200 to 300 ft.?

2. How is a 3-phase motor reversed?

3. With the steam at an initial pressure of 100 lb. gage and at a final or exhaust pressure of 10 lb. gage, which would take the more steam, a 50-hp. single-valve engine expanding the steam to 10 lb. or a reducing valve delivering steam at that pressure, the load carried to be the same in each case? R. D.

ANSWERS

THE CHOICE of an insulation for an underground steam line depends largely upon whether it is high or low-pressure steam, and whether running in a tunnel or conduit.

For separate lines carried in a tunnel, any standard covering of magnesia, asbestos or diatomaceous earth is usually employed. In low-pressure conduit construction, some commercial types endeavor to combine protection and insulation features in one material, serving as conduit and covering at the same time.

The segmental or wood log conduit, as approved by the American District Steam Co., is a notable example of this type. Radial staves, 2 or 4 in. thick, are bound together with galvanized steel wire and the outside of the casing is coated with ¼ in. of asphaltum pitch and rolled in sawdust. These wood casings are commonly made of such a size as to give a dead air space around the pipe of 1 or 2 in., the pipe being held in a central position by means of guides or runners.

In the Johns-Manville conduit, high and low-pressure lines are supported on special anchor tees inside of a split tile, and are insulated by packing the air space between the pipes and shell of conduit with some loose filling material such as Asbestos-Sponge conduit filling.

The "Ric-Wil" tile conduit made by the Richards-Wilson Co., is somewhat similar to the conduit just described except that it has an insulating layer of diatomaceous earth moulded on the inner face of the tile.

Waterproofed, reinforced concrete tile is also used extensively, the conduit or pipe covering consisting of a high-grade insulating material.

2. A 3-phase motor may be reversed by interchanging any 2 leads.

3. Apparently, with other conditions equal, more steam would be required when passed through the engine, due to the radiation and condensation losses during expansion in the engine cylinder, which losses are almost negligible in a reducing valve. Directly opposed to this theory, however, actual practice has disclosed the fact that exhaust steam from an engine is a more efficient heating medium, equal quantities considered, than steam passed through a reducing valve. One reason advanced for this peculiar result is that the exhaust steam is more moist, and in issuing from the engine in puffs enters the heating system in a more diffused state and thus gives up its heat to the radiating surface more readily.

Presenting, as it does, so many peculiar angles, this problem is still open to further discussion and no definite solution can be offered until a large number of careful tests have established more authentic results. W. P.

Power Factor Correction Problem

ON ACCOUNT OF low power factor, we have recently installed a synchronous condenser, and I would very much appreciate having you give me the per cent gain by the use of this condenser. We have a 3-phase generator operating several hundred small 220-v. induction motors. The condenser is connected to the bus bars, while our wattmeters are connected to the branch circuit, hence the wattmeters do not get the load of the condenser which is approximately 15 kw.

Our readings before using the condenser were 240 v., 500 amp. and 71 kw.; since using the condenser they are 240 v., 320 amp. and 71 kw.

Do the condenser losses add the additional load on the engine without any direct benefit to the motors? W. W. K.

A. The synchronous condenser will not have any effect on the power delivered to the motors, since this must depend on the load which the motors are carrying.

The benefit of the synchronous condenser is in the raising of the power factor. It is probable that, with your induction motor load, your power factor was not over 70 per cent without the synchronous condenser, while with the condenser, of proper proportion, it should be possible to raise this power factor to 90 per cent or better. This means that the amount of the current that you are supplying to the motors is decreased just in proportion to the increase in the power factor in order to deliver the same kilowatt output from the motors.

There would be a slight decrease in the electrical losses in the motors, because of this less amount of current required, but very likely this would not be sufficient to show on the kilowatt meter. The saving is in the line and generator losses, which should be sufficient to make a material decrease in the load on the engine and generator.

The fact that you are reducing your amperes from 500 to 320 is a very good index of the saving in line and generator losses that is being effected. A. L. R.

Covering Cold Water Pipes

WHAT COULD you advise using on cold water pipes to prevent sweating? W. B. McC.

A. A covering of granulated cork will give satisfaction with this class of service. A layer of felt which has been soaked in hot resin and then held to the pipe by stout cord until it has set has also been widely used on cold water pipes. W. P.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Is Your Opinion?

I WISH the readers of Practical Engineer would give me their opinions as to the cause of the following condition of an 8-pole compound-wound direct-current generator which was recently brought to my attention.

Upon examination, I found 32 commutator bars in 4 sets of 8 each burned, one of each set being quite black but with the following bars somewhat lighter; the commutator was slightly flattened at these points, sufficiently to cause the 8 sets of brushes to jump at every revolution. What cause would you give for this? J. C. L.

A Troublesome Bearing

MOST MODERN electric generators are provided with bearings grooved as shown in the accompanying sketch, Fig. 1; the main grooves are about ⅛ in. wide and ⅛ in. deep and carry the oil to the ends of the bearing, where it is received by channels and from there allowed to drain to the oil well below through holes provided for the purpose.

If the bearing of the generator referred to by F. H., on page 207 of the Feb. 15 issue, is so constructed, it is probable that his trouble is due to the oil holes being

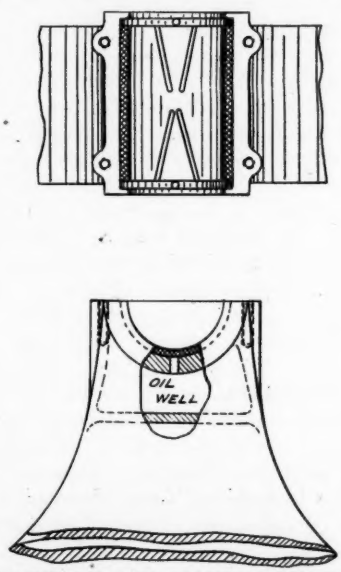


FIG. 1. OIL GROOVES AND DRAINS PROVIDED TO PREVENT OIL CREEPING ALONG ARMATURE SHAFT

plugged with dirt. A cleaning of these will therefore be quite beneficial. If, however, his bearing is not so constructed, he should remove the box from the pillow block and make the necessary changes in order that the bearing may conform to that shown in Fig. 1.

R. A. DIX.

I WOULD ADVISE F. H. to make his bearing as indicated herewith, Fig. 2. At a distance of about 5/16 in. from each end cut a groove 5/16 in. wide and at the bottom of each of these grooves drill 3 3/16-in. holes, thus allowing the oil to find its way into these grooves

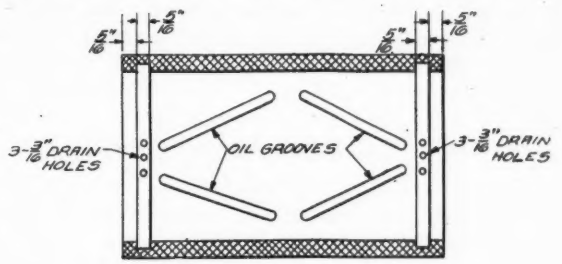


FIG. 2. DESIGN OF BEARING SUGGESTED BY F. BUDIG

and drain through the 3 holes into the basin below, instead of creeping out along the shaft.

FRANK BUDIG.

TO PREVENT trouble such as F. H. is experiencing, it is usual to shrink a collar on the shaft (or leave it on when turning down the shaft in the machine shop), either just inside of the bearing housing, that is, between the housing and quarter boxes, or outside, where it is covered by the oil guard. The oil creeps out along the

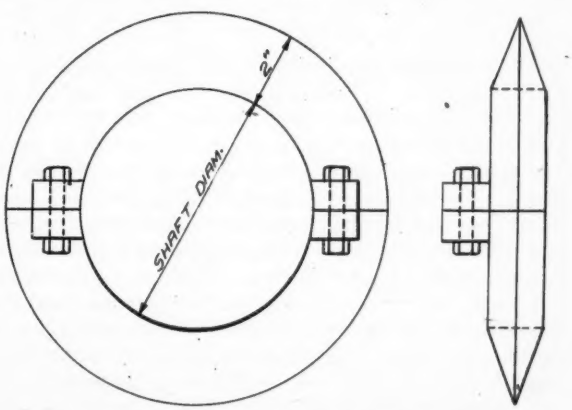


FIG. 3. J. H. CASE RECOMMENDS USE OF THIS COLLAR TO PREVENT OIL CREEPING ALONG SHAFT

shaft until it reaches this collar, then due to centrifugal force it is carried to the outer edge of the collar and is thrown off. If the shaft of the generator referred to by F. H. has no such oil collars, they may readily be made as shown, Fig. 3, the construction being such that the two halves of the collar may be bolted around the

shaft. Should there be no room for it inside of the bearing housing attach it outside of this, but as close to the bearing as possible. J. H. CASE.

I HAD similar trouble with a 75-kw. direct-connected engine-driven generating set having a 4¾-in. shaft. To overcome this trouble, which I succeeded in doing, I turned down a 2-in. length of casting to an overall diameter of 7 in., and an inside diameter of 5 in., and on the inside surface cut 2 grooves, one ½ in. wide and ⅝ in. deep and the other ¾ in. wide with the same depth. I then slipped this ring around the shaft and attached it to the bearing pedestal with the large groove filled with a ¾-in. ring of hemp packing on the outside. The shaft rubbing against this packing caused it to pick up whatever oil that did find its way outside of the bearing and when the packing became saturated, the surplus oil was directed into the small groove. A ⅛-in. hole drilled in this acted as a drain. JESSE REARICK.

Corliss Valve Lubrication Trouble

HAVING HAD valve lubrication trouble similar to that mentioned by P. H. W., on page 206 of the Feb. 15 issue, the method I employed to overcome it may prove of interest to him and perhaps some of the other readers of Practical Engineer.

CORLISS VALVE WITH OIL GROOVES

I removed the valves, and placing them in a lathe, cut an oil groove at each end, as shown in the accompanying sketch. Since then the rubbing and groaning has stopped and I have been able to use considerably cheaper grade of oil. WM. FUNK.

Examination Questions from Massachusetts

IN THE ISSUE of Mar. 15, under the heading, Examination Questions from Massachusetts, W. E. Aldrich is in error in some of his answers. In answer to question 2, as to how the speed of a Corliss engine can be changed, he advocates changing the length of the horizontal rods leading from governor to the releasing mechanism, so cutoff will occur later. Should this be done, the effect would be to take more steam for one stroke, or possibly a very few strokes, and this would speed up the engine, thereby causing the governor to rise and shorten the cutoff, bringing the engine to its former speed. The only difference would be to cause the governor to stand higher.

The proper way to increase the speed would be to increase the diameter of pulley on governor shaft, or decrease diameter of pulley on engine shaft. For example: Suppose a governor should run at 200 r.p.m.; the small pulley is 6 in. in diameter, the pulley on engine shaft is 15 in. This will give an engine speed equal to the product of 200 times 6 divided by 15, or 80. Should it be desired to increase the speed of the engine to 90 r.p.m., we would multiply proposed speed by diameter of shaft pulley and divide by revolutions of governor, as, the product of 90 times 15 divided by 200, or 6¾ in. Or using same size small governor pulley and making change of pulley on engine shaft we would have as follows: The product of 200 times 6, divided by 90, or approximately 13 11/32 in.

Some makes of Corliss governors are provided with hollow center weights; these can be loaded with shot, thereby increasing the speed. The principle of this is that a faster rotation of governor balls is necessary to develop enough centrifugal force to lift the center weight.

In answer to question 9, "on which side of the crankpin does a connecting rod with a solid end take up?" the answer given is: "Usually on side towards the piston, in which case the tendency is to increase the length of the rod."

The connecting rods of engines built years ago generally had their means of taking up brasses toward the body of the rod, but the progressive builders of today have generally the takeup of crosshead box, toward body of rod, and the takeup of crank box toward end of rod, thereby tending to preserve the original length.

To question 12, the "steam pressure and speed remaining the same, how would you make a Corliss engine develop more power," the answer given is to "change length of rods which connect valve cranks with wrist plate, giving the engine a later cutoff." Now, the cutoff of a Corliss is controlled by the governor, and should always be so controlled. The cutoff changes as the load changes, and if an indicator diagram was taken, allowing the pencil to move over the paper for several revolutions with a variable load, we would get quite a range of cutoffs, with the same pressure of steam at its admission, and the speed of the engine would be practically the same. Some engines cut off with the governor on what is termed the safety stop, or collar; some governors have to rise off the stop before the dashpots will drop. But should the governor rods be changed, so the governor will rise *higher* before the dashpots drop, the engine will develop more power, for the reason that the engine will carry the hooks easier than usual. But, on the other hand, should the governor rods be changed too much when the governor is at its highest point, too much steam will be admitted to the cylinder. Should the load be thrown off or lightened a great deal it would cause the engine to run away. It is not advisable to make much of a change unless the operator thoroughly understands the action and probable consequences.

If the engine is a single eccentric engine, more power can be developed by changing into a double eccentric engine than by giving the engine a larger range of cutoff, as indicated in the answer to question 5. Also, more power can be obtained if a condenser is added.

TOM JONES.

IN READING over the examination questions of the Massachusetts Board of Examining Engineers, I noticed one question somewhat similar to one that appeared in another issue, namely: How would you set the valves on a Corliss engine running condensing?

The answers in both cases were a great deal alike, stating that if the valves were set correctly for noncondensing, no change need be made running condensing.

The answers did not appeal to me as being applicable in all cases, as an experience I once had will show. We were running a horizontal, cross-compound, 1200-hp. Allis-Chalmers engine condensing, using a Wheeler surface condenser. A centrifugal circulating pump was direct connected to a small slide valve engine, when one forenoon about 10 o'clock the crank shaft on this engine broke, shutting down the circulating pump. Of course, we lost our vacuum, the atmospheric relief valve opened and the engine ran noncondensing. The low-pressure side began to rattle and thump as if it were going to break loose.

Being only a short while till noon we let it run as it was. At noon we shut down and moved the exhaust eccentric until the edges of the valves and ports were line in line. We then started up, admitting live steam (about 15 lb.) into the low-pressure cylinder through a bypass valve, and the engine ran as smoothly noncondensing as it did condensing. The exhaust valve had had considerable lap when running condensing, and an indicator card, taken when running under this setting, showed fine results. I did not get a card when it ran noncondensing, so I cannot say how it ran. The next day the crankshaft was welded and we changed back to condensing.

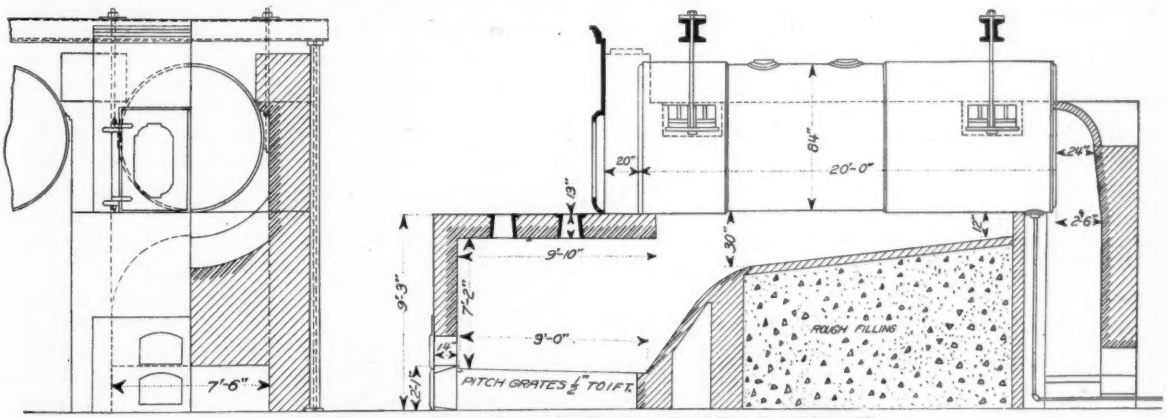
On another day, about a year after this accident, a similar one took place on another unit, a 400-hp. cross-compound vertical Allis-Chalmers engine direct connected to a 440-volt, 3-phase, 60-cycle generator. In this case, we did not shift the exhaust eccentric, but made a slight change in the head end exhaust valve, giving it less lap than it had and admitted live steam (about 6 lb. in this case) into the low-pressure cylinder; it also ran smoothly.

My experience has been limited, as far as condensing engines are concerned, and whether the above tactics could be used in all cases I do not know; but if some reader who has had more experience than I will tell us whether these tactics were good, I would much appreciate reading criticisms in another issue. I have no desire to criticise the answers to the questions mentioned, but I would like to bring about a discussion as to whether all Corliss engines will run smoothly and economically, condensing, when the valves are set for noncondensing.

In setting valves for noncondensing, the exhaust valves are given a slight lead, some engineers setting them line to line, depending, of course, upon the amount of compression desired. If a certain amount of compression is given a noncondensing engine, it seems only logical that the amount of lead given the exhaust valves must be decreased or given a slight lap to make up the same amount of compression when changed to condensing, considering that the back pressure is changed from 14.7 lb. absolute to 2 lb. absolute when running with a 26-in. vacuum. G. R.

Referring to the answer to question 11, page 283 of the March 15 issue, I wish to say that if you are operating an engine noncondensing and wish to change over to condensing, you must change your exhaust valves so as to give more compression; that is, compression great enough to carry well above the atmospheric line. If this is not done, the engine will make considerable noise.

Although the answer to question 4 of this same set would pass, it is not quite correct, as the angle of advance has not been taken into consideration. You really cannot obtain cutoff as late as ½ stroke on a single eccentric engine. W. S.



SETTING CONSTRUCTION SUGGESTED BY JOHN I. HASTINGS

What Setting Construction Would You Advise?

Relative to the unsatisfactory boiler setting employed by E. A. Green and as described on page 247 of the March 1 issue, I would suggest that he make the alterations indicated in the accompanying sketch. I have employed this kind of setting on boilers with ordinary furnaces for 50 yr. or more, and always with good results, and can see no reason why it should not work in this case.

I would lower the bridge wall to about 30 in. from the boiler and then fill in from bridge wall to smoke box, carrying this filling higher at the rear end. Then turn a reverse arch of brick, following the curvature of the boiler shell from bridge wall at 30 in. up to within about 12 in. at the rear end, with the corner at bridge wall well rounded. Also, cover in top of boiler with brick. I can see no good in holding the intense heat close to the boiler at the bridge wall and then letting it get as far from the shell at rear end as possible.

Years ago I changed furnaces on these lines and have had reports of 25 per cent saving in fuel and much easier firing. John I. Hastings.

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Next, What?

By the message of President Wilson, and the logic of events, the United States of America stands committed to active participation in the great struggle for representative government, responsible to the people against autocratic rule under the control of inherited power.

No conquest is sought, no indemnity will be asked. This nation stands only for its rights and the right of humanity to choose its own form of government. Our contention is for freedom, the same as in past wars, and involves no thought or purpose of material gain.

We find ourselves facing active warfare with inadequate preparation. The reasons are not worth arguing just now. The vital question for each man is, What Next? What need of our country can I meet?

Three needs must be met. For money, for men, for equipment. Expenses must be met by taxation and bond issues. Taxes will be arranged by Congress and we must be prepared to pay them promptly. It is to be hoped that such bond issues as are authorized will be so divided that all can participate in loaning to the government such sums as can be spared from daily needs. And rigid economy so as to increase the spare funds is a true loyal service. The Chamber of Commerce of the United States is holding a conference of heads of committees to cooperate with the Council of National Defense for the purpose of insuring that equipment and supplies shall be bought economically and that a minimum of profit shall be allowed to manufacturers who furnish such materials, thus making certain that funds loaned to the government will be used to the best advantage.

Men must be had to form the Navy and Army. Conscription and drafting are words that have carried, heretofore, a certain odium, partly as implying compulsion of individuals by the government, partly as indicating want of patriotism of those so selected. There can be no question of the devotion to country of those who voluntarily enlist either in Regular Army or National Guard. Those who have no obligations or responsibilities to hinder can well meet this need by personal service, and will have the advantage of choosing what branch they will enter. But it seems probable that the numbers required cannot be secured in this way, and the method of drafting from those most eligible for service seems the only fair recourse. The duty then will be to go readily when summoned, and for those who remain, to recognize the service which those who go are to render, and to make every effort to see that the men who go in are kept supplied with arms, ammunition, equipment and such comforts as may be, in order that they may fight to the best advantage and be subject to a minimum of hardship.

Along these two lines seem to lie the greatest opportunities for service and patriotism for most of us. To those who are directly concerned in the manufacture or furnishing of equipment or supplies, will come also the duty of making sure that nothing but the best of materials and workmanship are used.

Our boys at the front must be sure of the best we can furnish to help them in the work that they are doing for us and ours.

These are immediate duties. But what about a year or 2 years from now? God grant that long before that

time the present struggle may be over. If not, shall our government still be drafting men to meet its needs? The alternative is to prepare now. And Universal Military Training and Service is the fair and just answer.

As soon as possible Congress should know that the people want a law passed which will distribute the defense of this country fairly among all the people. If each man and woman lets his or her representatives in the House and Senate know that the people will to have a real democracy of service as well as privilege, the law will be passed. Your letters will help. That is another next duty that you can and should attend to.

We are in this war, not because we wish it, but for the cause of right and humanity. The United States of America expects every man to do his duty.

High Prices and the Power Plant

Prices are soaring. It requires no argument to prove that. Everybody who has bought food, clothing, fuel or any other commodity will readily admit it.

Fuel, a prime necessity in every industry from home-making to munitions manufacture, has shown exceptional wings during the past winter, and the outlook for any great decrease does not seem hopeful. Prices double and treble those of a year ago are common, the increase in cost of product, especially in central stations and plants of buildings, being a serious matter. So that the bettering of fuel economy has become more than ever a matter of great consequence.

Another item that closely affects the power house is copper, which now carries a market price twice that of a few months ago. For electrical machinery and transmission, copper is a fundamental material; aluminum and iron may be substituted, for transmission, but the scarcity of aluminum practically bars that from being considered. Iron may be used for long lines carrying light loads, but for heavy currents the inductive effect and high resistance are a serious objection. The inductance can be somewhat overcome by the rotary condenser; but this again involves a costly machine, so that the combination is hardly feasible except for big enterprises. The use of high voltage cuts down the cost of copper for transmission lines, but requires extra cost for insulation and safeguarding, although it seems to offer the best solution of the problem for moderate length lines and heavy loads.

For electrical machinery, no material is available to replace copper, and it would seem that the only recourse against high cost of copper is to make every pound of the metal do its full duty by keeping it at work at full capacity as much of the time as possible. To accomplish this requires careful study to secure high load factor and such interconnection of plants with different times of peak as will reduce idleness and light load periods to a minimum on every machine and line.

This is important also from the fuel standpoint, as a lightly loaded machine or line always works at low efficiency and wastes fuel. The present conditions do not offer much promise of relief from high fuel cost, as car shortage is continuing, and until this is relieved no large reserves are likely to be accumulated by dealers. Some lowering of price may come during the summer months, but unless steps are taken to provide a supply against next winter's needs, a shortage will again be encountered that will send prices skyward.

Anthracite can easily be stored with no special precautions, but bituminous requires care to guard against spontaneous combustion and deterioration from the weather.

Small piles are a precaution against the fire risk but add to the weathering loss, so that the two are conflicting in requirement. Small piles under cover are ideal but expensive. The small pile of bituminous covered with a layer of lignite may be an experiment worth trying, or a thatch of cheap material such as swamp grass might be serviceable.

It is likely that war conditions will so increase the demand for the Pocahontas or smokeless coals of the West Virginia region for naval purposes that little will be available for civil use. Hence it would seem the part of wisdom to prepare to use lower grades of eastern coal in the eastern plants and the coal of Ohio, Indiana, Illinois and Iowa in the plants of the central and western states, even for low pressure heating, and furnaces should be fitted accordingly.

It is in the heating plant that the greatest difficulty arises in burning western coals without smoke, on account of the low rate of combustion and infrequent firing. The change will mean learning and practicing a different method of handling the fires so as to keep a thin, hot fuel bed and supply air above the fuel in the proportions needed for complete combustion. And as the high prices will make economy of fuel of more importance than ever, a thorough overhauling of furnaces to get rid of air leaks, to provide control of air above the fire and plenty of combustion space above the grates, also a good draft and easy means for close damper regulation would seem to be a necessary part of the summer preparation for next winter's conditions.

In tests conducted by the Iowa State College of Agriculture and Mechanic Arts on combustion engines operating in that state as given in the official publication, it was found that the high-compression Diesel type has lower fuel consumption and burns a cheaper fuel than the medium-compression or semi-Diesel; also that the latter has a like advantage over the low-compression or carburetion type; but the first cost is in inverse order of the fuel advantage. Monthly operation shows a fuel consumption of from 2.6 to 1.03 pints of fuel oil per kilowatt-hour generated, the costs for fuel being 1.3 to 0.39 cents per kw.-hr., the higher figure being for carburetion engines rated at 220 hp. and using fuel costing 4 cents a gallon; while the lower cost is from a 225-hp. Diesel engine using oil at 3 cents a gallon.

Based on fuel prices for 1914-15, the operating costs in cents for various types are given as follows:

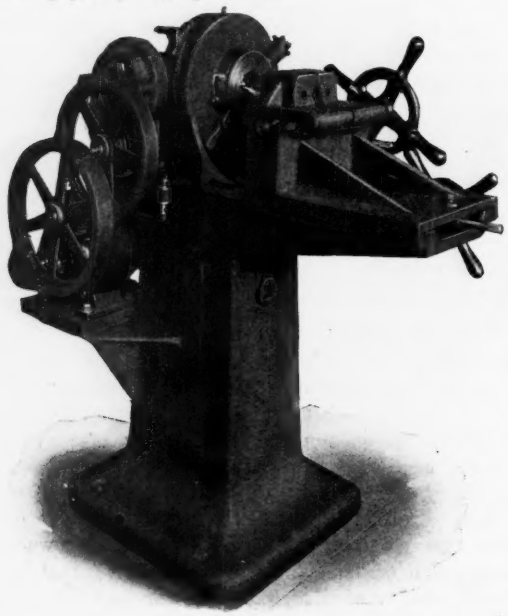
	Type of Engine		
Cost per—	Carburetion 50 hp.	Semi-Diesel 50 hp.	Diesel 120 hp
Brake hp.-hr.....	2.91	2.75	1.72
Kw. hr. generated....	6.60	6.28	3.50
Kw. hr. delivered on line	9.79	9.39	3.50
Kw. hr. delivered to consumer	14.83	14.34	5.78

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Oster Combination Threading and Cutting-Off Machine

THE Oster Manufacturing Co., of Cleveland, O., has developed a line of pipe and nipple machines which perform every one of the many pipe threading jobs ordinarily required. The illustration shows the company's 300-B machine for ¼ to 2-in. pipe. It is operated by a ¾-hp., direct or alternating current, Westinghouse motor. The motor is mounted on the machine base and is direct connected. It has ample power and speed for all classes of work. Machines for from 1 to 4-in. pipe are operated by 1½-hp. motors, for from 1¼ to 6-in. by 1¾-hp. motors, and for from 2½ to 8-in. pipe, by 2½-hp. motors.



OSTER MOTOR DRIVEN THREADING AND CUTTING-OFF MACHINE

Type 300-B is a combination threading and cutting-off machine, a combination pipe, nipple and bolt machine. It will thread bolts from 7/16 to 1¼ in. The regular standard equipment consists of motor, geared oil pump, automatic cutoff apparatus, automatic die release, and 4 sets of right-hand pipe dies from ¼ to 2 in. The special features are the lever operating die head and the open type pipe vise, making the machine a rapid producer. The dies are automatically oiled and the operator can see the work of threading at all times.

One of the great advantages of the machine is the open type vise which enables the operator to change the work quickly and thereby increase the capacity. Every operating part is right under the hand so that not a moment is wasted. Without changing his position, the operator can see the work of the threading dies at all times. The vise grips the work by a single turn of the wheel, bringing it to an absolute center. The vise can be moved up close to the die head for threading short pieces, short bends, nipples, bolts, and casings.

The quick die release feature of the machine makes possible the opening of the dies at the instant the thread is finished. It opens the dies gradually and removes the burr, leaving a clean, perfect thread. At the same time, the vise carrying the pipe is thrown back, withdrawing the pipe from the die head. When adjusted for the length to be cut, it will repeat automatically without any attention on the part of the operator.

Each die is made to cut like a lathe tool. One set of dies will thread 2 or more sizes. The dies are controlled by a lever handle, and are opened or closed by one movement of the hand while the machine is in motion. The lever handle is fastened to the die arm and is used in releasing the dies when the thread is cut, in setting them to same size for making duplicate threads, in changing the dies from one size to another, and in setting them to graduation on the face plates. When the thread is finished, it is only necessary to trip the die lever and this opens the dies right off the work, without making it necessary to stop the machine.

The cutting-off apparatus works automatically by means of a pawl attached to the frame of the machine. The cutter is set into the end of the sleeve and fastened with a screw. The star wheel is attached to a long screw which operates the sleeve holding the cutter. A ratchet attachment automatically regulates the feed of the cutter.

Anti-Acid Valves

DURING the past year there was an exceptionally great demand for valves made entirely of iron for use in handling cyanides and other solutions which attack metals having copper as their basic element and which consequently could not be handled by brass valves or valves having any part made of brass. The demand was not confined to dye and chemical manufacturing plants, but has been noticed among mines, oil refineries, tanneries, pulp and chemical fiber mills, canning and packing establishments, etc.

The Lunkenheimer Co. states that in the manufacture of its all-iron valves a composition is used that is exceptionally free from impurities, resulting in solidity of grain structure which insures great strength and makes the castings more resistant to corrosion and chemical attack.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps

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PRACTICAL ENGINEER

TABLE I. STEAM DRIVEN AIR COMPRESSORS

Cost Of Coal At One Dollar Per Ton To Compress And Deliver 100 Cu. Ft. of Free Air

(Multiply figures in table by price of coal in dollars per ton) Ton = 2000 lb.

Weight of Steam - In Pounds - Required by the Engine - Per Horsepower per Hour.	24	26	28	30	32	34	36	38	40	42
Weight of Coal - In Pounds - Per Horsepower Per Hour - When Boiler Is Evaporating 7 lb. of Water Per Pound Of Coal.	3.43	3.714	4.	4.286	4.571	4.757	5.143	5.428	5.714	6.
Brake H.P. to deliver 100 cu.ft. free air per minute	Cost of Coal Per H.P. Hour At One Dollar Per Ton - -Fractions of Cent-									
	.1715	.1857	.2	.2143	.2285	.2376	.2571	.2714	.2857	.3
	Cost Of Coal Per 100 Cubic Feet Free Air - -Fractions of Cent-									
16	.0457	.0495	.0533	.0572	.0610	.0634	.0686	.0724	.0762	.08
18	.0514	.0557	.06	.0643	.0686	.0714	.0772	.0814	.0857	.09
20	.057	.0619	.0667	.0714	.0762	.0793	.0857	.0904	.0952	.10
22	.0627	.0681	.0733	.0785	.0838	.0872	.0943	.0995	.1047	.11
24	.0684	.0743	.08	.0857	.0914	.0951	.1029	.1085	.1142	.12
26	.0741	.0805	.0866	.0929	.099	.103	.1114	.1175	.1238	.13
28	.0798	.0867	.0933	.10	.1066	.1109	.12	.1266	.1334	.14
30	.0855	.0929	.10	.1071	.1142	.1189	.1285	.1357	.1429	.15

Example - If it requires 22 brake horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and the compressor is driven by an ordinary steam engine requiring 34 lb. of steam per horsepower hour, and an ordinary boiler evaporating 7 lb. of water per pound of coal, and with coal at $4 a ton - the coal cost per 100 cubic feet of free air is .0872 x 6 = .5232 cent.

H. V. Conrad.

PRACTICAL ENGINEER

TABLE III. ELECTRIC DRIVEN AIR COMPRESSORS

Cost Of Electric Current In Cents To Compress And Deliver 100 Cubic Feet Of Free Air

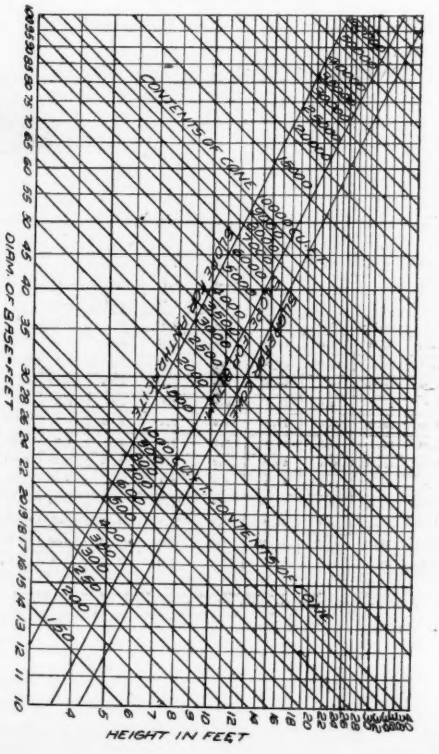
Brake Hp. To Deliver 100 Cu. Ft. Free Air Per Minute	Price Of Electric Current Per Kilowatt-Hour - Cents						
	1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.
	Per Horsepower Hour - Cents								
.75	1.125	1.5	1.875	2.25	2.625	3.	3.375	3.75	
16	.2	.3	.4	.5	.6	.7	.8	.9	1.0
18	.225	.337	.45	.562	.675	.787	.9	1.012	1.125
20	.25	.375	.5	.625	.75	.875	1.0	1.125	1.25
22	.275	.412	.55	.687	.825	.962	1.1	1.237	1.375
24	.3	.45	.6	.75	.9	1.05	1.2	1.35	1.5
26	.325	.487	.65	.812	.975	1.137	1.3	1.46	1.625
28	.35	.525	.7	.875	1.05	1.225	1.4	1.575	1.75
30	.375	.562	.75	.937	1.125	1.312	1.5	1.687	1.875

Example:- If it requires 22 Brake Horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and electric current at 4. cents per Kilowatt-hour, the electric current cost per 100 cubic feet of free air is 1.1 cents.

H. V. Conrad.

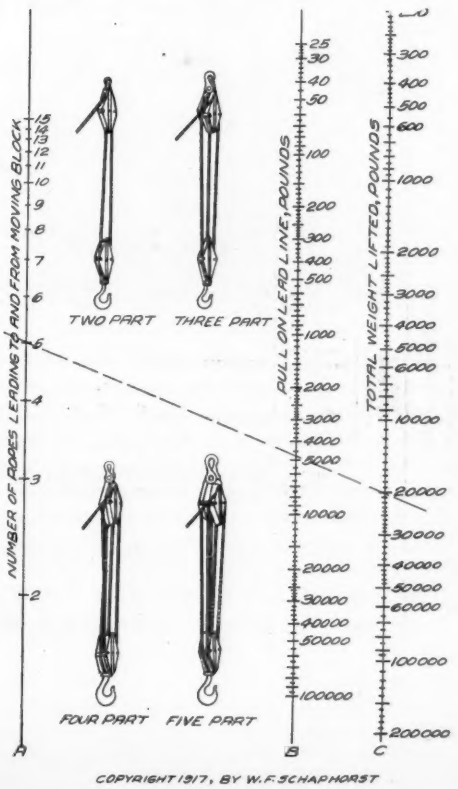
PRACTICAL ENGINEER

CHART FOR ESTIMATING VOLUME OF A CONE



PRACTICAL ENGINEER

COMPUTING CHART FOR WIRE ROPE



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POWER TO COMPRESS AIR AT DIFFERENT ALTITUDES

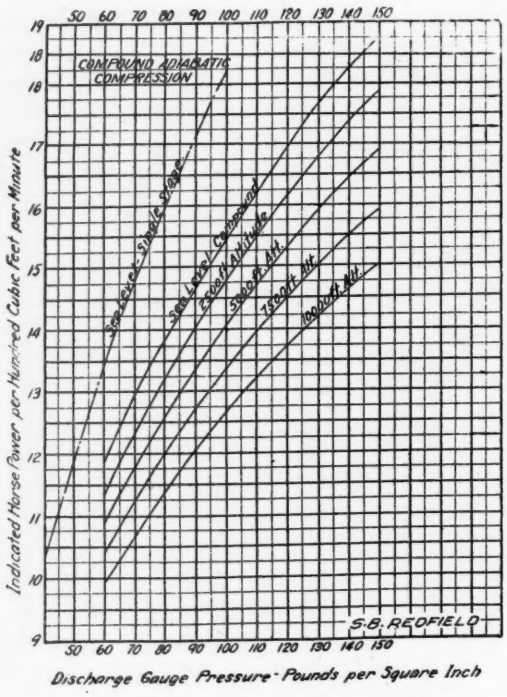
COMPOUND ADIABATIC COMPRESSION
Sea Level - Single Stage
Sea Level - Compound
2500 Altitude
5000 ft. Alt.
7500 ft. Alt.
10000 ft. Alt.
S.B. REDFIELD
Indicated Horse Power per Hundred Cubic Feet per Minute
Discharge Gauge Pressure - Pounds per Square Inch

TABLE II. GASOLINE DRIVEN AIR COMPRESSORS

Cost Of Gasoline In Cents To Compress And Deliver 100 Cubic Feet Of Free Air.

Gasoline Consumption One Pint Per Brake Horsepower Per Hour

Brake Horsepower to Deliver 100 Cubic Feet Free Air Per Minute	Price Of Gasoline Per Gallon -Cents-							
	8	9	10	11	12	13	14	15
16	.266	.300	.333	.366	.400	.433	.466	.500
18	.300	.337	.375	.413	.450	.487	.525	.562
20	.333	.375	.416	.458	.500	.542	.584	.625
22	.366	.412	.458	.504	.550	.595	.642	.687
24	.400	.450	.500	.550	.600	.650	.700	.750
26	.433	.488	.542	.596	.650	.705	.759	.813
28	.466	.525	.583	.642	.700	.758	.816	.875
30	.500	.563	.625	.688	.750	.813	.875	.936

Example:- If it requires 22 Brake Horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and gasoline at 22 cents per gallon, the gasoline cost per 100 cubic feet of free air is .504 x 2 = 1.08 cents.

H. V. Conrad.

STANDARD HOISTING WIRE ROPE

Composed of 6 strands and a hemp center, 19 wires to the strand
(John A. Roebling's Sons Co.)

Trade number	Diam., in.	Approx. wt. per ft., lb.	Diameter of drum or sheave advised, ft.		Proper working load, tons of 2000 lb.				
			For steel	For Swedish iron	Swedish iron	Cast steel	Extra strong cast steel	Plow steel	Improved plow steel
00	2⅜	11.95	11	17	22.2	42.2	48.6	55.0	63.0
0	2⅛	9.85	10	15	18.4	34.0	40.0	46.0	42.0
1	2¼	8.0	9	14	14.4	26.6	32.0	37.0	42.0
2	2⅛	6.35	8	12	11.2	21.6	24.6	28.0	30.0
2½	1⅞	5.55	8	12	10.0	19.0	22.4	25.0	30.0
3	1¾	4.85	7	11	8.8	17.0	19.8	22.0	27.0
4	1⅝	4.15	6½	10	7.6	14.4	16.6	19.0	22.0
5	1½	3.55	6	9	6.6	12.8	14.6	16.0	20.0
5½	1⅜	3.0	5½	8½	5.6	11.2	12.8	14.0	17.0
6	1¼	2.45	5	7½	4.56	9.4	10.6	12.0	14.0
7	1⅛	2.0	4½	7	3.72	7.6	8.6	9.4	11.0
8	1	1.58	4	6	2.90	6.0	6.80	7.6	9.0
9	⅞	1.20	3½	5½	2.36	4.6	5.20	5.8	7.0
10	¾	0.89	3	4½	1.70	3.5	4.04	4.6	5.3
10½	⅝	0.62	2½	4	1.20	2.5	2.80	3.1	3.8
10½	⅝	0.50	2¼	3½	0.94	2.0	2.24	2.4	2.9
10¼	½	0.39	2	3	0.78	1.68	1.84	2.0	2.4
10c	7/16	0.30	1¾	2¾	0.58	1.30	1.45	1.6	1.9
10b	7/16	0.22	1½	2¼	0.48	0.96	1.06	1.15	1.35
10a	5/16	0.15	1¼	2	0.30	0.62	0.70	0.76	0.9
10d	¼	0.10	1	1½	0.22	0.44	0.49	0.53	0.53

WEIGHT OF COAL IN PILE—TONS

Volume	Anthracite		Bituminous or Lignite		Peat or Turf		Charcoal		Coke	
Cu. Ft.	Loose	Settled	Loose	Settled	Loose	Settled	Loose	Settled	Loose	Settled
1	47 lb.	58 lb.	40 lb.	54 lb.	20 lb.	26 lb.	10 lb.	14 lb.	23 lb.	32 lb.
50	1.18	1.45	1.0	1.35	0.5	0.65	0.25	0.35	0.58	0.8
100	2.35	2.9	2.0	2.7	1.0	1.3	0.5	0.7	1.15	1.6
150	3.53	4.35	3.0	4.05	1.5	1.95	0.75	1.05	1.73	2.4
200	4.7	5.8	4.0	5.4	2.0	2.6	1.0	1.4	2.3	3.2
250	5.88	7.25	5.0	6.75	2.5	3.25	1.25	1.75	2.88	4.0
300	7.05	8.7	6.0	8.1	3.0	3.9	1.5	2.1	3.45	4.8
350	8.23	10.15	7.0	9.45	3.5	4.55	1.75	2.45	4.03	5.6
400	9.4	11.6	8.0	10.8	4.0	5.2	2.0	2.8	4.6	6.4
450	10.58	13.05	9.0	12.15	4.5	5.85	2.25	3.15	5.18	7.2
500	11.75	14.5	10.0	13.5	5.0	6.5	2.5	3.5	5.75	8.0
550	12.93	15.95	11.0	14.85	5.5	7.15	2.75	3.85	6.35	8.8
600	14.1	17.4	12.0	16.2	6.0	7.8	3.0	4.2	6.9	9.6
650	15.28	18.85	13.0	17.55	6.5	8.45	3.25	4.55	7.48	10.4
700	16.45	20.3	14.0	18.9	7.0	9.1	3.5	4.9	8.05	11.2
750	17.63	21.75	15.0	20.25	7.5	9.75	3.75	5.25	8.65	12.0
800	18.8	23.2	16.0	21.6	8.0	10.4	4.0	5.6	9.2	12.8
850	19.98	24.65	17.0	22.95	8.5	11.05	4.25	5.95	9.76	13.6
900	21.16	26.1	18.0	24.3	9.0	11.7	4.50	6.3	10.36	14.4
950	22.34	27.55	19.0	25.65	9.5	12.35	4.75	6.65	10.94	15.2
1000	23.5	29.0	20.0	27.0	10.0	13.0	5.0	7.0	11.5	16.0

The weight of greater volumes may easily be determined to the nearest 50 cu. ft. by multiplying the above values by multiples of 10 and adding, thus: The weight of 33,250 cu. ft. of settled bituminous is 13.5 x 100 plus 8.1 x 10 plus 6.75 = 1457.5 tons.

For use in handling the more severe solution, such as caustic soda, caustic potash, soda-ash and other similar alkaline liquids, the company employs a composition known as "Lunkenheimer Nickel-iron." This metal has exceptional acid-resisting qualities and the long and satisfactory service rendered has led many to use valves made of this material even for the weaker solutions.

Special composition brass or bronze valves best resist the chemical attacks of some acids and again a nickel composition is found the better adapted, and for this reason the nature of the liquid to be handled should be considered in order to enable the selection of the proper material.

News Notes

At a meeting of Editors of the Chicago Trade Press Association, held on Mar. 23, 1917, resolutions were adopted pledging the support of the papers represented to the President of the United States in maintaining the honor and integrity of the country, also the use and support of the editorial columns to counsel readers to stand back of the President in defending the rights of humanity. The conference urged the President and Members of Congress to enact into law at once a bill providing for universal military training.

An organization of gear manufacturers was formed at Lakewood, N. J., at a meeting held there Mar. 25 and 27. This organization will be known as the American Gear Manufacturers Association. Its purposes are to advance and improve the gear industry in a general way by standardization of gear design, manufacture and application. This association includes in its membership the foremost and better known manufacturers of gears.

The executive committee is composed of the following: F. W. Sinram, Van Dorn & Dutton Co., Cleveland, O.; H. E. Eberhardt, Newark Gear Cutting Machine Co., Newark, N. J.; F. D. Hamlin, Earle Gear & Machine Co., Philadelphia, Pa.; Frank Horsburgh, Horsburgh & Scott, Cleveland, O.; Biddle Arthur, Simonds Mfg. Co., Pittsburgh, Pa.; Geo. L. Markland, Philadelphia Gear Works, Philadelphia, Pa.; Milton Rupert, R. D. Nuttall Co., Pittsburgh, Pa.

The officers elected at the Lakewood meeting are the following: President, F. W. Sinram; vice-president, H. E. Eberhardt; secretary, F. D. Hamlin; treasurer, Frank Horsburgh.

The next meeting of the association will be held at Pittsburgh, May 14 and 15.

On Mar. 19, 1917, the Boston office of the Ashton Valve Co., including the executive, sales and credit departments, was transferred to its factory in East Cambridge, where more commodious quarters have been provided for the conduct of its greatly increased business. Hereafter all correspondence as well as deliveries should be sent to the Ashton Valve Co., 161-179 First St., Cambridge, "C," Boston, Mass.

A special meeting of the managers and district engineers of the Combustion Engineering Corporation for the Eastern District of the United States was held at the general office of the company, 11 Broadway, Mar. 22. This session was called for the purpose of discussing plans that are to be put in immediate operation for increasing the output of the shops, and enlarging the service and operating departments in this district by organizing new erecting units and approving extension to plants to take care of the large increase in business.

Harry Tipper, who has been associated with the Texas Co. for 9 yr., first as sales engineer and then as advertising manager, has resigned, and will, on May 1, become general manager of the Automobile, 239 West 39th St. Mr. Tipper is a real engineer, having served in the engineering department of the Texas Co. He is president of the Advertising Club of New York, and has for years been one of the most prominent figures in the advertising profession, as well as a prolific writer on that subject.

Appreciating the importance of securing the ability and training of the engineers of the country for use in national defense measures, President Wilson has appointed a number of prominent engineers in the country to positions in the army.

One of the appointments which will meet with the most hearty approval of the electrical engineering profession is that of Paul M. Lincoln, commercial engineer of the Westinghouse Electric & Manufacturing Co., as Captain of the Engineers Corps of the U. S. Army. Announcement has just been made of this appointment, together with a number of other prominent engineers.

Mr. Lincoln graduated from Ohio State University in 1892, and has for 24 yr. been associated with the Westinghouse Electric & Manufacturing Co. He is past president of the American Institute of Electrical Engineers, and has always taken an active interest in the work of this association.

Geo. H. Gibson Co., advertising engineers, Tribune Building, New York, have recently taken new and larger space in that building in order to serve more efficiently their growing list of clients.

RICKARD & SLOAN, INC., whose slogan is "Productive Publicity," and whose address is 20 Vesey St., New York, has been obliged to take additional space in order to accommodate increasing business.

THE NEW YORK OFFICE of Whitney-Felker Co., high pressure piping, has been removed from 350 West 38th St., New York, to 511 West 42nd St., New York.

W. F. SCHAPHORST, advertising engineer, and author of technical articles that have been published in Practical Engineer, has established an engineering advertising service office in the Woolworth Bldg., New York City.

THE NATIONAL ASSOCIATION OF COTTON MANUFACTURERS will hold its 102nd Annual Meeting at the Copley-Plaza Hotel, Boston, April 25 and 26. Among papers to be presented will be one on The Evolution of the Steam Turbine, by John A. Stevens, and conferences on Employment and Management and on Factory Safety and Sanitation.

THE CONSOLIDATED ENGINE STOP CO., having found it impossible to keep pace with the rapidly growing demand for its products in its present quarters, 350 West 38th St., New York, are removing to 511 West 42nd St., New York, where their manufacturing facilities will be greatly increased.

Trade Notes

THE CARRIER Air Conditioning Co., Buffalo, N. Y., has received an order for one of its generator coolers Compagnies Reunies Gaz & Electricite, of Lisbon, Portugal. This equipment is to be complete with motor-driven spray pump and patented Cyclone nozzles of the non-clogging type. The turbo generator, whose air supply is to be washed and cooled, is 9400 kv.a. rating. Following the practice in the United States, dry filters are being discarded for wet washers on account of the many advantages.

THE COMBUSTION ENGINEERING CORPORATION announces that Walter H. Wood, mechanical engineer, has become associated with its staff of combustion experts. Mr. Wood has an outstanding record as a combustion engineer, having been associated with his brother, A. C. Wood, consulting engineer, of Philadelphia, for a number of years. He was later engaged by several prominent concerns to solve combustion problems. He has recently been superintendent of power plants of the Baltimore & Ohio Railroad Co., which connection he severs to enter the employ of the Combustion Engineering Corporation as Engineer of Tests and Research.

This latest move on the part of the Combustion Engineering Corporation further emphasizes its policy of service and equipment to handle any combustion problems that may be presented, and it is this policy that explains, in a measure, the enormous success of that company which in the last 3 yr. has 4 times doubled its capacity for output of the various kinds of stokers that it manufactures. G. E. Learnard, vice-president and general manager of the company, states that over 1,500,000 hp. is now being developed with its Type "E" stokers, in addition to which considerably over 500,000 hp. of its Coxe stokers for anthracite coal are in use.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By young man 21 yrs. in a power plan of 1000 k.w. or more where there is a good chance for advancement. Not particular about wages or kind of work to start with. Have had a year's experience night engineer in 25 kw. plant and one year as head of 200 hp. heating plant. Can furnish best of references. Strictly sober. Am anxious to learn, but patient. Address Box 200, Devil's Lake, N. D.
4-15-1

POSITION WANTED—As chief or first operating engineer by experienced and reliable power plant engineer, at present employed in one of the largest power houses in Northern Illinois; can furnish best of references; good reasons for changing. Address Box 476, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

POSITION WANTED—By man, 30 years old, good habits, married, with 6 years' experience in steam electric plants. Would like position as engineer in plant of 2500 k.w. capacity or more, where I can advance myself. Address Box 471 Pracical Engineer, 537 S. Dearborn St., Chicago, Illinois. 3-15-1

POSITION WANTED—Young man wishes position as oiler or assistant engineer in a plant in New York City. Two years' practical experience. Write William Brand, 24 Locust Hill Ave., Yonkers, N. Y. 4-1-1

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 4-1-1

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 4-1-1

POSITION WANTED—As Fireman or Oiler in large plant; 3 years, experience as fireman, 18 months as assistant engineer. Married. Strictly sober. Prefer Southern States. L. C. Drake, Cambridge City, Ind. 3-15-2

POSITION WANTED—As chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 4-1-1

POSITION WANTED—By young man, 23 yrs. old, as fireman or oiler in ice and electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 4-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal. Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Illinois. tf.

WANTED—Experienced salesmen, strictly commission basis, for the most efficient feed water heater and purifier on the market. State former connection, experience and territory covered. Moffat Feed Water Heater & Purifier Co., Dayton, Ohio. 4-1-2

WANTED—Men calling on the steam trade to introduce and sell "The worst enemy boiler scale ever had." Good territory and a good proposition open to live men who will work. The Rogers-Collins Co., Pontiac Bldg., St. Louis, Mo. tf.

For Sale

For SALE, in North Dakota town of 1000 population, electric light and power plant. Twenty-four-hour service. Plant in good condition. Distribution system covers entire town. Extensions well cared for. Good feed mill business in connection. Price, $30,000. Terms, one-third cash, balance to suit at 5 per cent interest. Address Box 474, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 3-15-4

FOR SALE—C. H. Wheeler surface condenser, 200 sq. ft. surface. Used in discharge line with 40-lb. water pressure. Water openings flanged 12-in. Approximately 7 ft. long, 30 in. diam. overall dimensions. Mullen air pump 4 in. x 8 in. by 6 in., both in perfect shape. Just replaced by larger units. Paducah Water Company, Paducah, Ky. 4-15-2

FOR SALE—Two 50 K. W. C. W. generators and Ball engines, $1,000 each; 25 K. W. G. E. generator and Ball engine, $550; 15 K. W. G. E. generator and marine engine, $550; 9 K. W. G. E. generator and engine, $400. Power Machinery Exchange, Inc., 1 Montgomery St., New York, N. Y. 4-15-1

WE HAVE for sale the following steam pumps: 1 Gardner duplex, 2½ by 1½ by 3; 1 Gardner duplex, 5 by 3½ by 5, brass lined; 1 Cameron simplex, 5 by 2½ by 7. All are in good running condition, original wrenches to accompany them. Replaced by electric-driven pumps. Address Culpeper Lt. & Ice Co., Culpeper, Va. 4-15-1

FOR SALE—One direct reading ohmmeter and resistance measuring set, 1 portable galvanometer, voltmeters and ammeters, 2 Amsler's planimeters. All new. Address Box 477, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 4-15-1

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS — Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Proof That Advertising Lowers Selling Cost

The rising cost of living is the great universal hardship of the present day. So great and so many have these rises been that few people stop to realize that there have been any exceptions to the general rule. But the fact is that there have been numerous exceptions and all of these exceptions belong to the same great class—that of nationally advertised goods.

The old idea that the cost of advertising raises prices dies hard. But the business man knows better. He knows that selling goods is costly business—no matter what the goods or what the selling methods. And he knows that anything which creates demand on a large scale, and thus makes selling easier, is bound to reduce selling costs and thus helps to reduce prices.

But evidence is better than argument; facts are better than theories. The Association of National Advertisers, an organization of 260 of the leading advertisers of the country, has been at great pains to collect the facts. It has secured an immense body of data from its members which proves that advertising does reduce selling costs and thus tends to reduce the selling price of advertised goods. "The proof of the pudding" is the argument that settles everything.

To present all the evidence, instance by instance, is impossible within these limits. A few representative cases will suffice.

The makers of a famous photographic camera, when they began advertising twenty-eight years ago, made one camera which took a 2½-inch picture and which sold at $25. Today they make a far better camera which sells for $10. Another, which took a 4x5 picture, sold for $60. Today they sell a far better one for $20. And so on through the line.

A prominent hat manufacturer has, by means of advertising, reduced his selling cost seven cents per hat. Result—the buyer gets a hat of better quality at no increase in price; this despite increased cost of raw material and workmanship.

When the manufacturer of a famous breakfast food specialty began advertising, his goods sold at 15 cents a package. Today the package is fifty per cent larger and the price has been reduced to 10 cents. Again advertising did it, the same causes producing the same results.

The producer of another well known food specialty is selling his goods at 25 per cent less to the wholesale grocery trade than four years ago.

Twenty years ago a nationally advertised shaving stick was sold in a cheap metal leatherette covered box. Today a stick containing 20 per cent more soap is sold in a handsome nickel box at the same price.

Then take the most conspicuous example of them all—the automobile business; and compare the $5,000. or $10,000. cars of ten years ago with the equally good cars of today, selling for a fraction of the money.

And so on through a long list. In every case, the manufacturer either has been able to lower the price or improve the quality at no increase in price.

How has he done it? By means of advertising, which has created demand on a larger scale and thus permitted production and distribution on a large scale. Result—improved manufacturing efficiency and reduced selling costs. And all of this in the face of a steady increase in the cost of labor and raw materials which, with advertising eliminated, might in many cases have fairly doubled the price of the goods.

"A triumph of economical marketing" is the only possible verdict for advertising in the face of these facts.